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(54) **HYBRID HIGH INTEGRITY PRESSURE PROTECTION SYSTEMS AND VALVES**

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F16K 17/16	(2006.01)
F16K 25/04	(2006.01)

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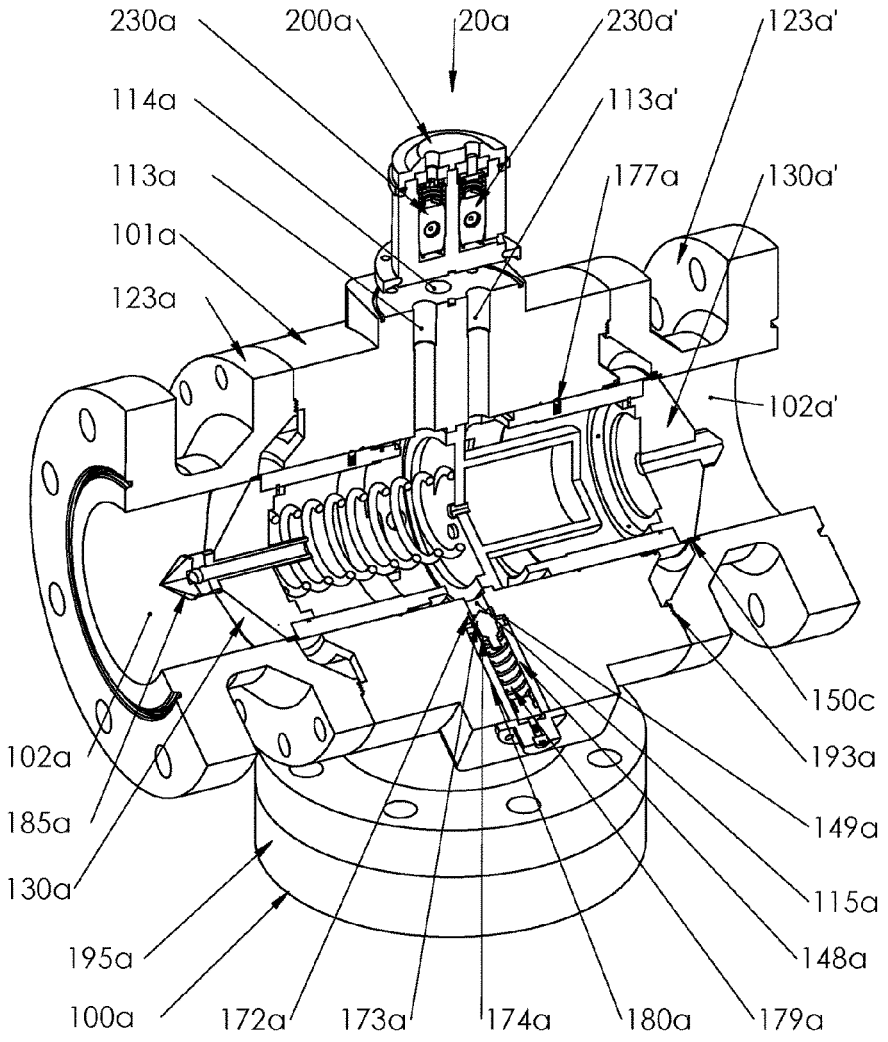
CPC ***G05D 16/106*** (2013.01); ***F16K 25/04*** (2013.01); ***F16K 17/16*** (2013.01)

(57) **ABSTRACT**

This invention relates to a Hybrid High Integrity Pressure Protection System (H-HIPPS) for severe services, the hybrid system includes a quick isolation subsystem between an overpressure zone and a normal pressure zone and a quick releasing subsystem between the overpressure zone and a lower pressure zone with quadruple redundancies for 30 year service without repair more particularly, the hybrid system has a novel valve and a novel pilot each with two independent plugs with metal to metal seal—(buckling seal) B ring assemblies and a novel (attachable)) A seal ring assembly to block or release over pressurize fluids without actuators for protecting the pipelines or the pressures vessels from surge pressure at the highest level of a system reliability with a fast block off time, redundant sensing valves, redundant releasing methods, redundant pressure protections, and cavitations and erosion suppressor.



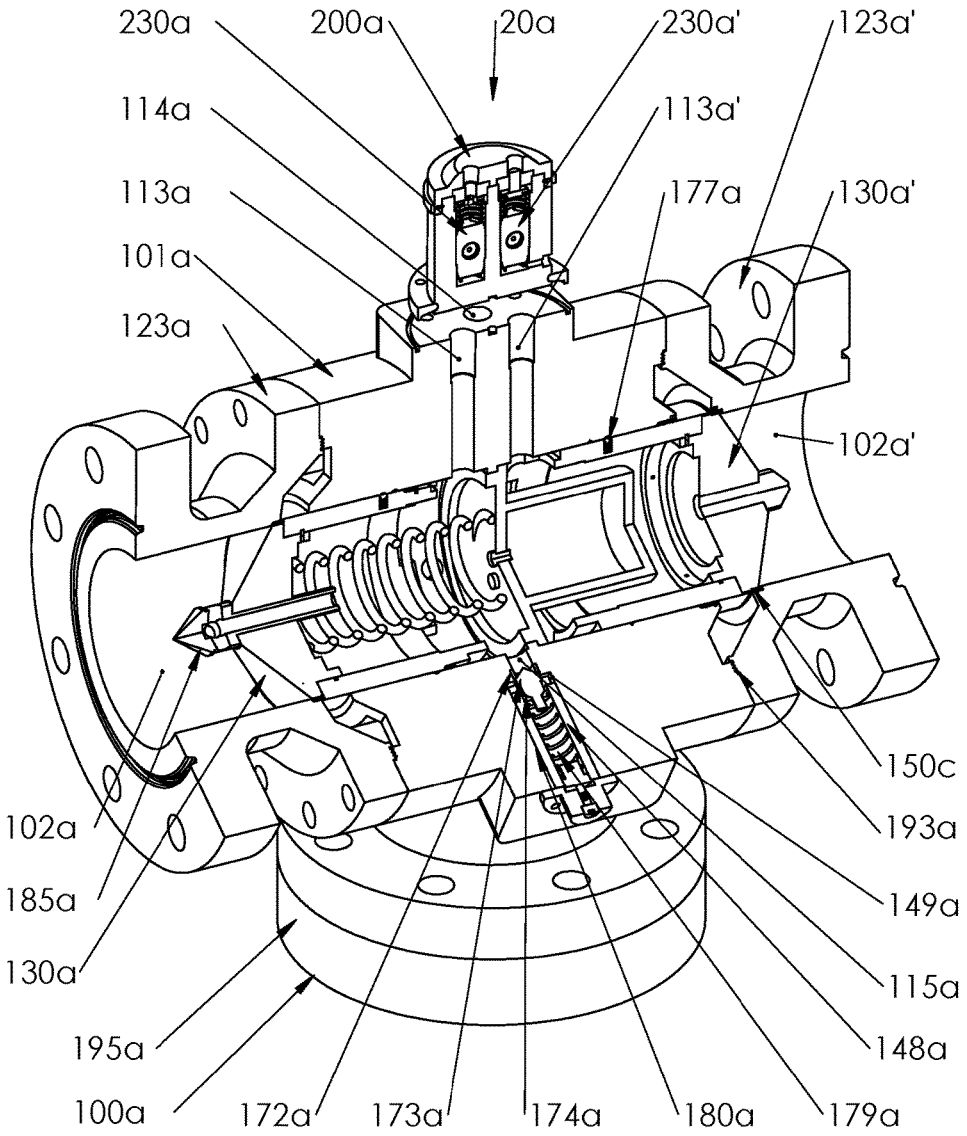

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FIG. 1

FIG.4

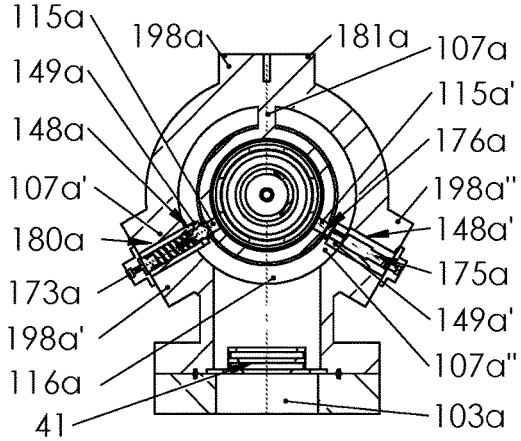


FIG.3

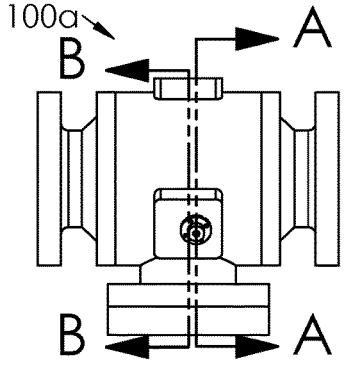


FIG.6

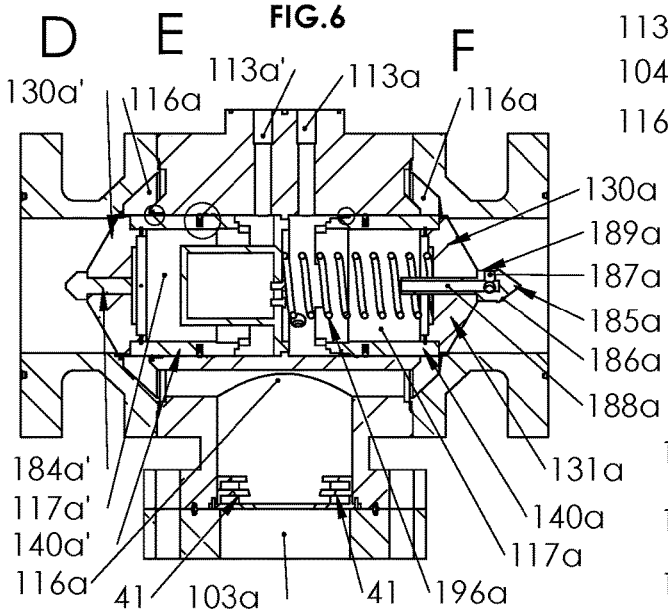


FIG.5

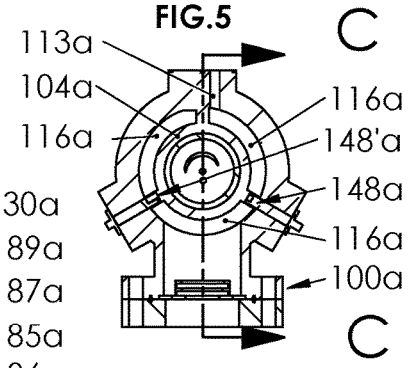
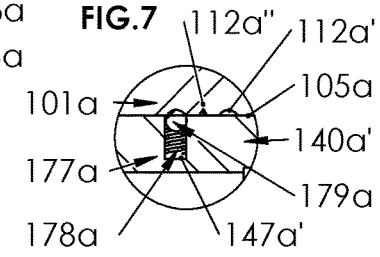


FIG.7



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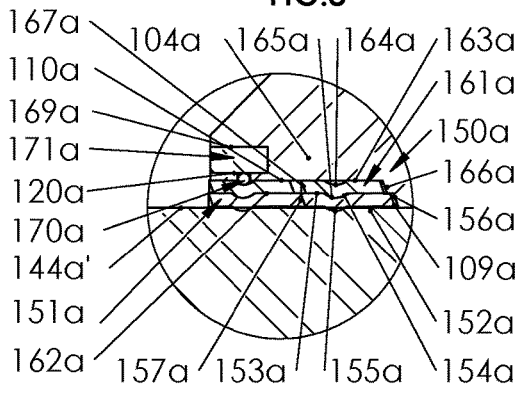
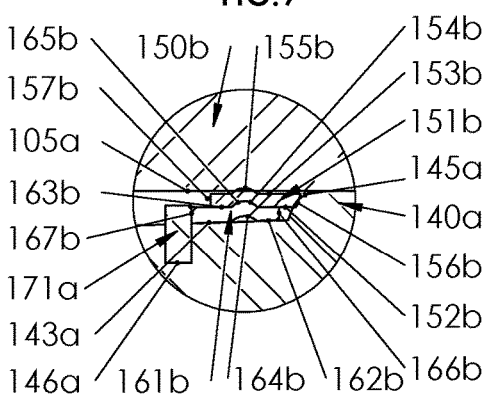


FIG.9



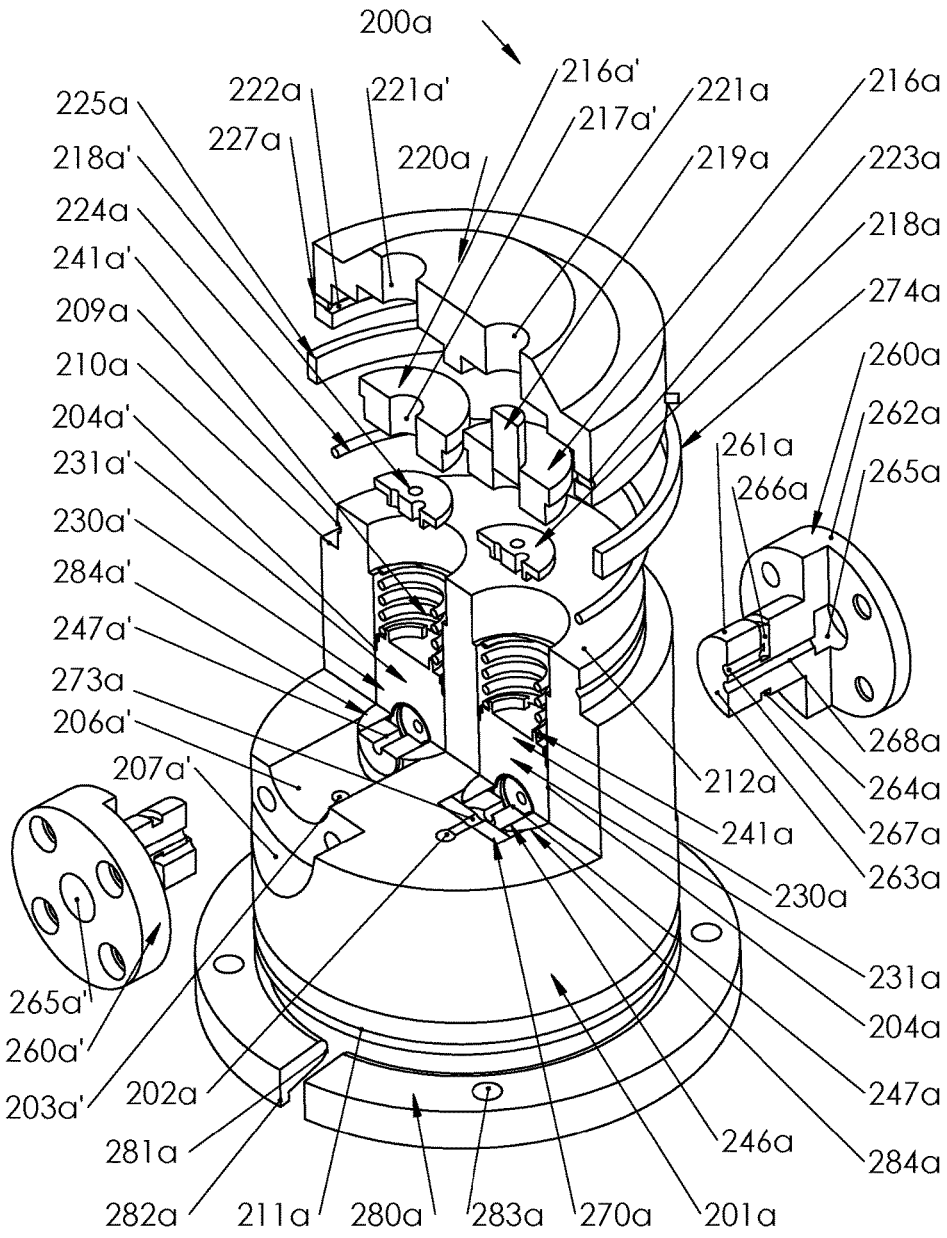

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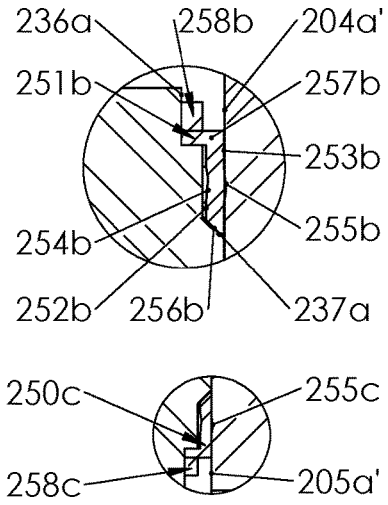
FIG.2

FIG.15



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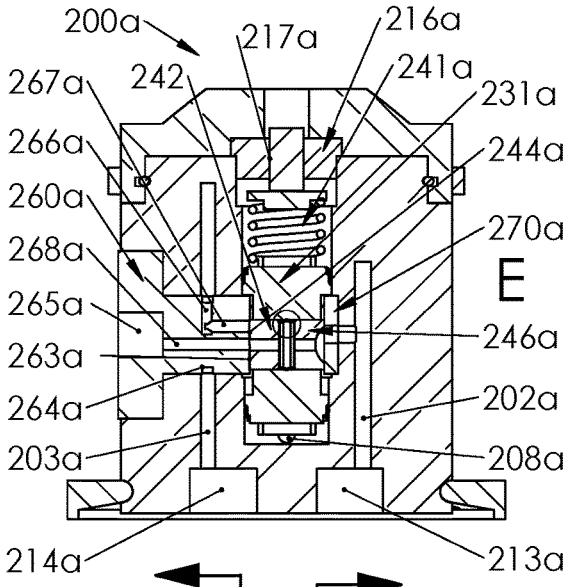

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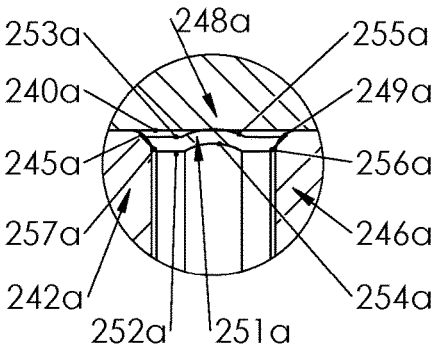


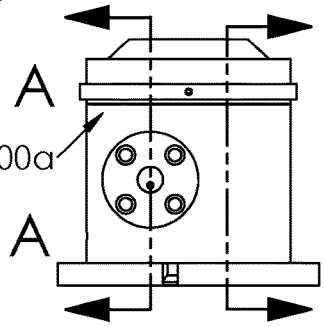


FIG.10

FIG.11

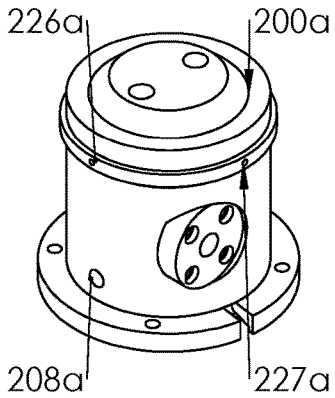
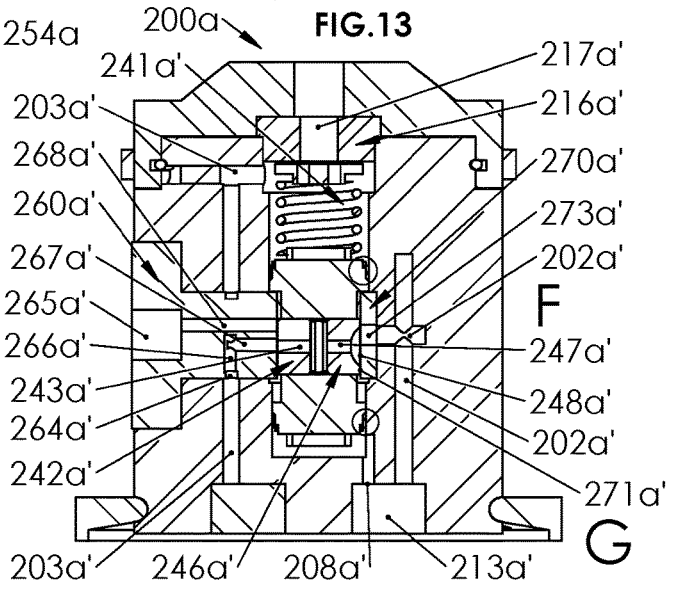


FIG.13



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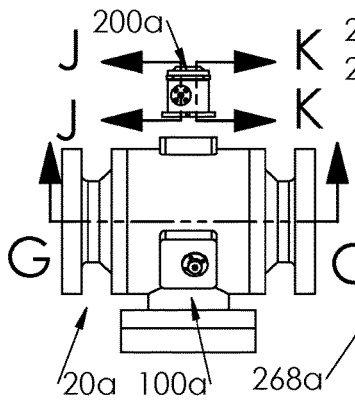

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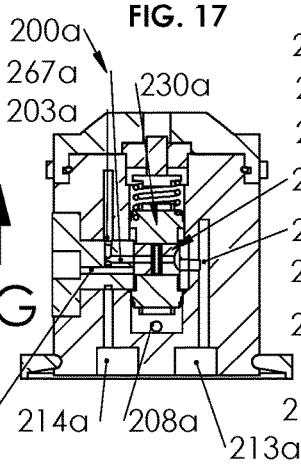

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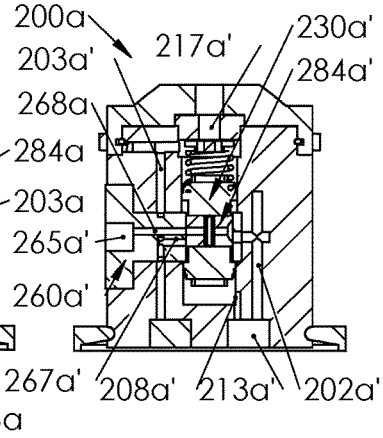

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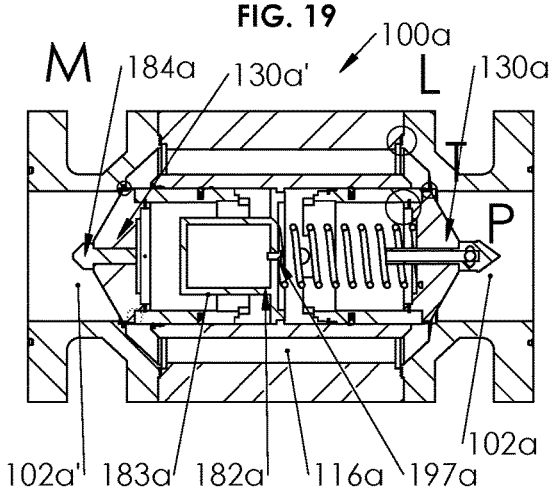

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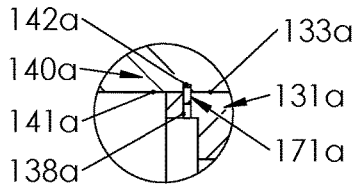

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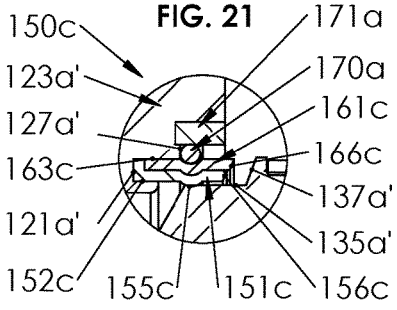

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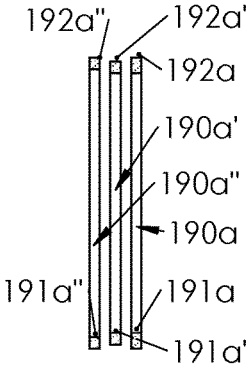

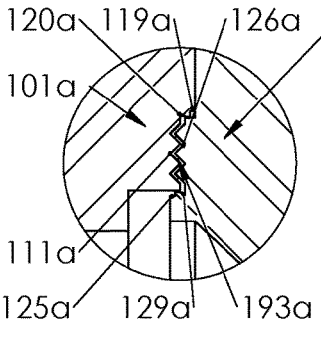

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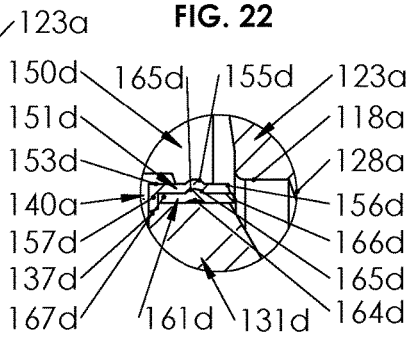

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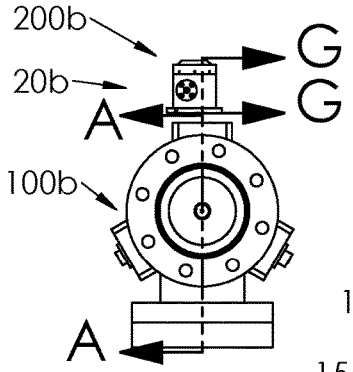

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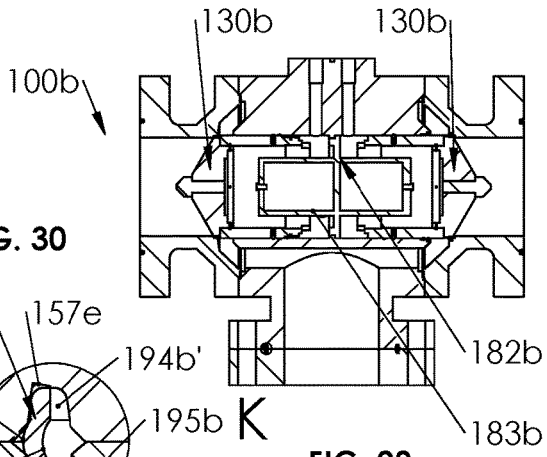

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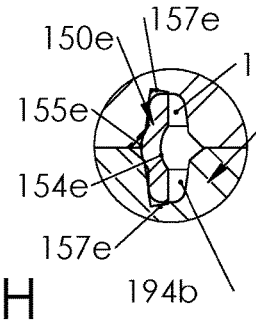

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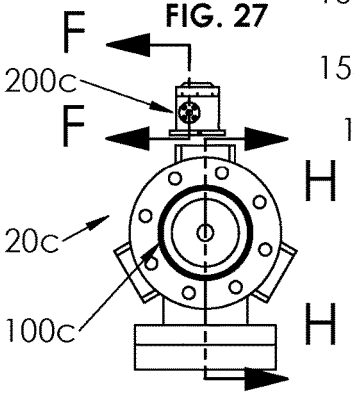
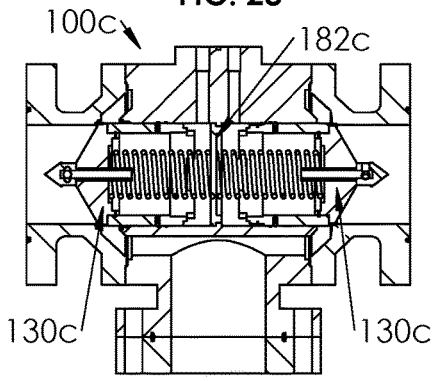


FIG. 28



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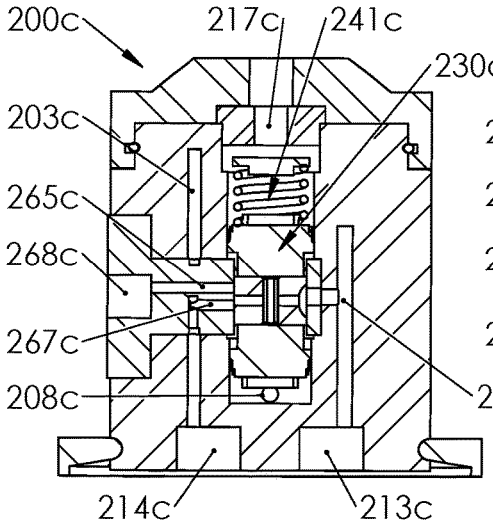

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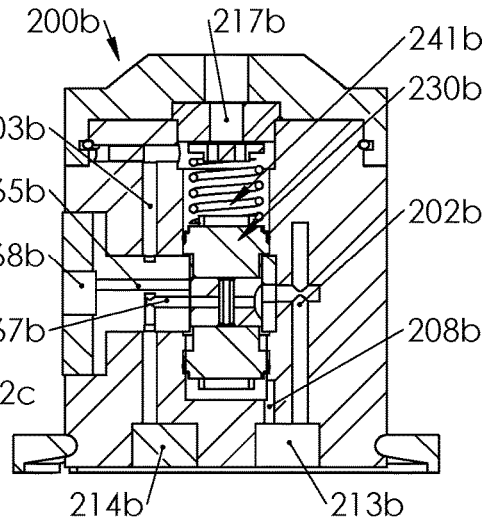

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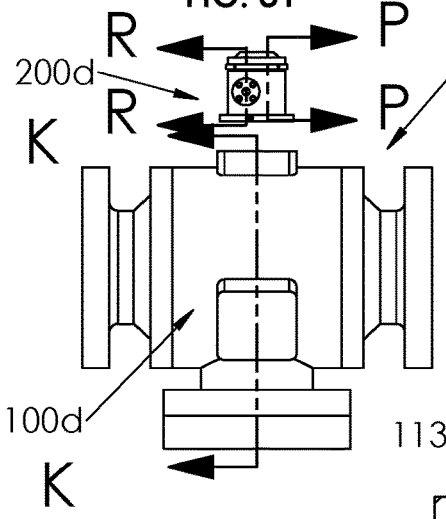

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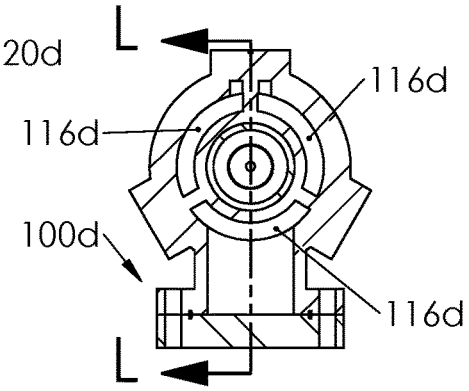

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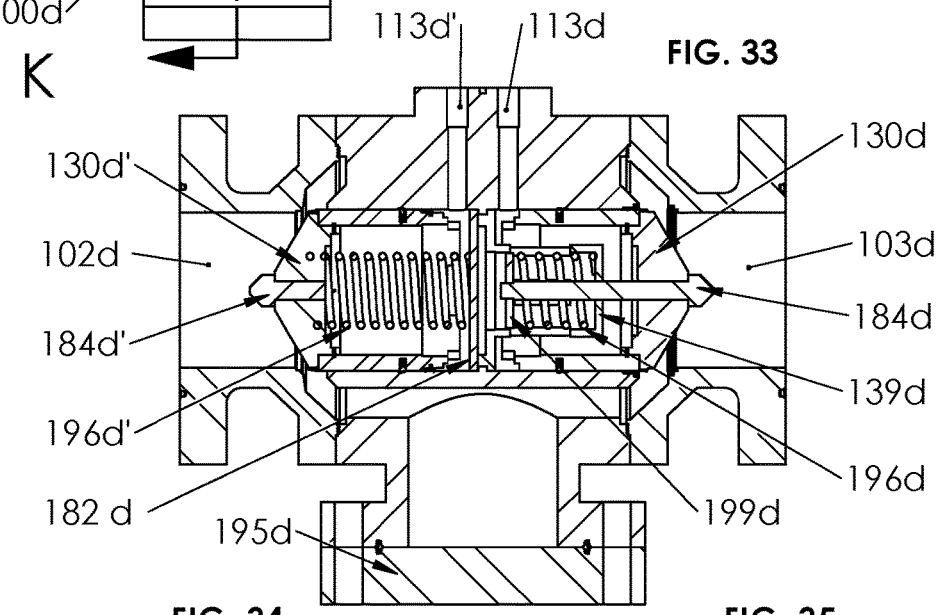

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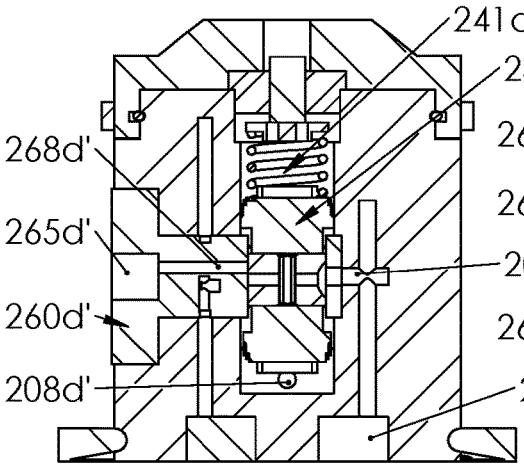
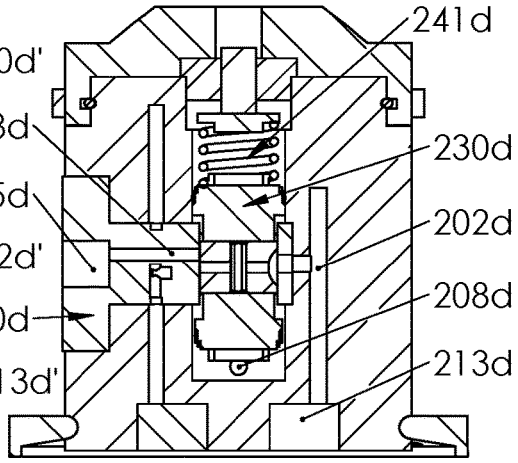


FIG. 35



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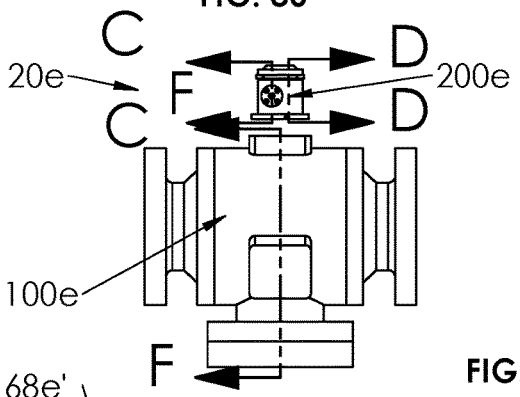

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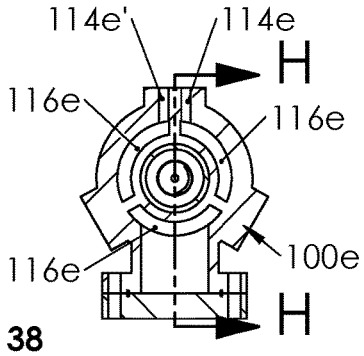

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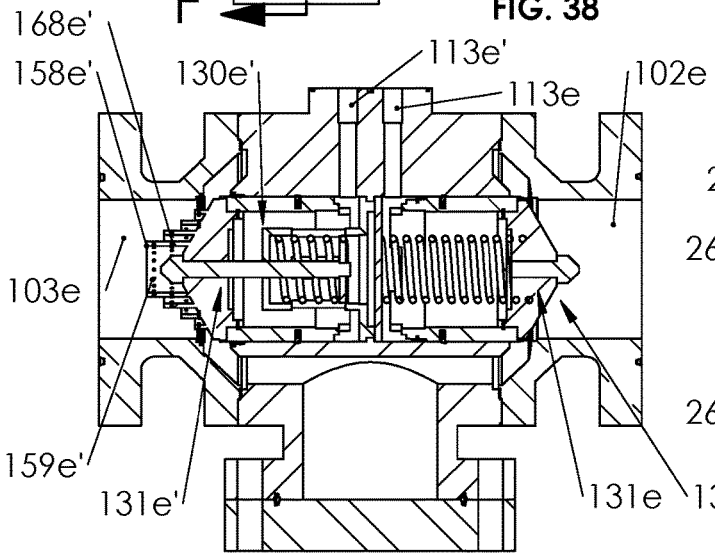

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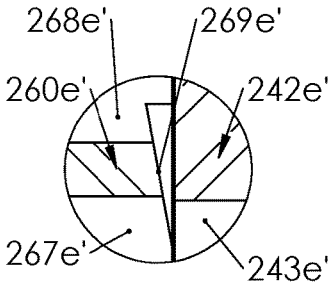

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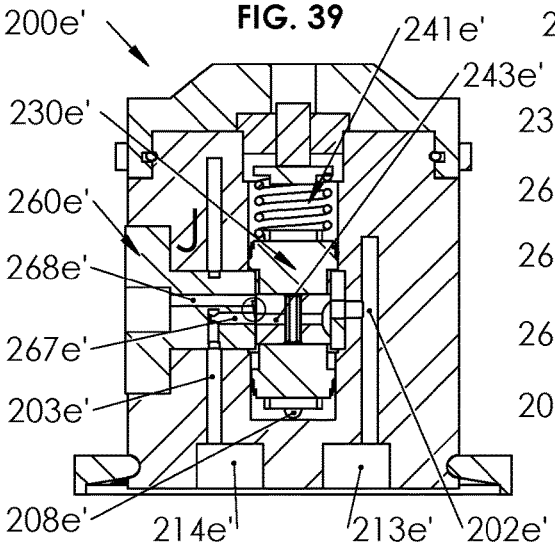

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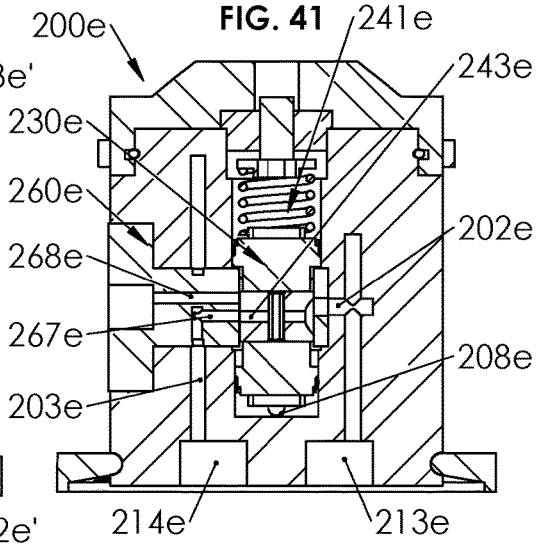

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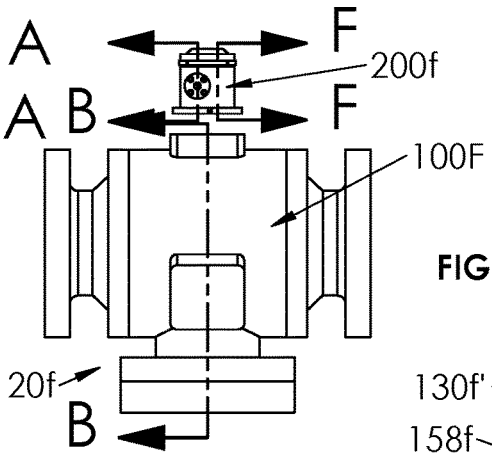

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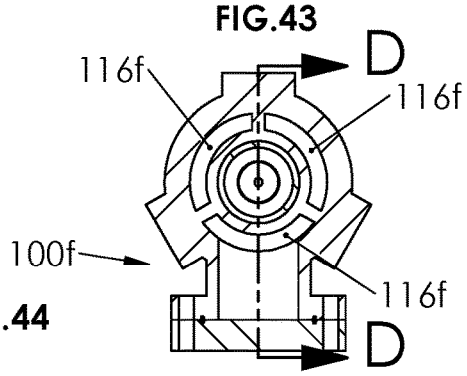


FIG.44

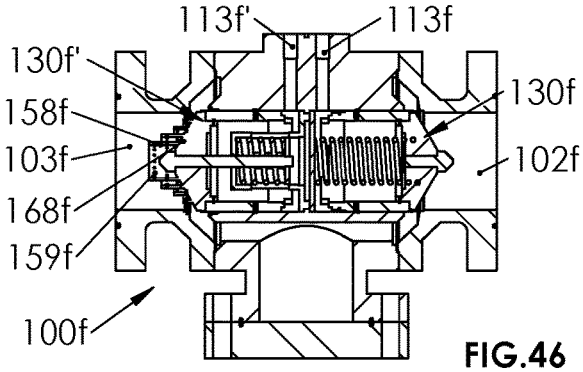


FIG.46

FIG.47

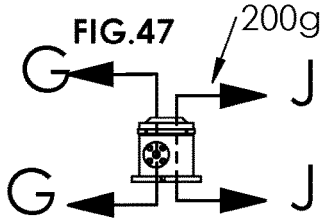
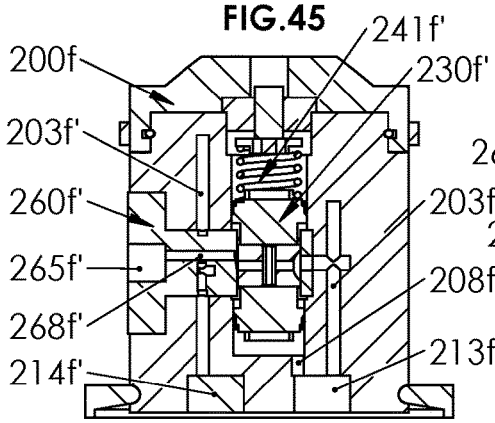


FIG.45



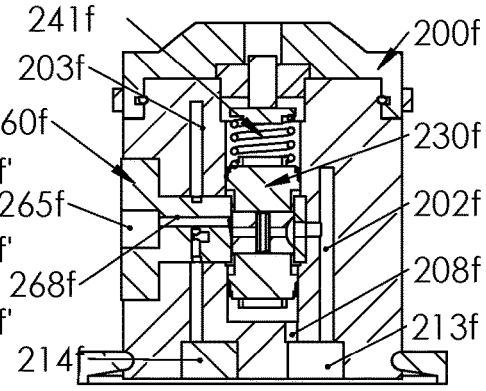


FIG.48

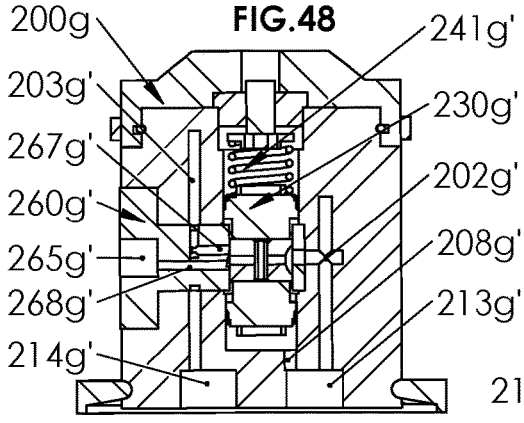


FIG.49

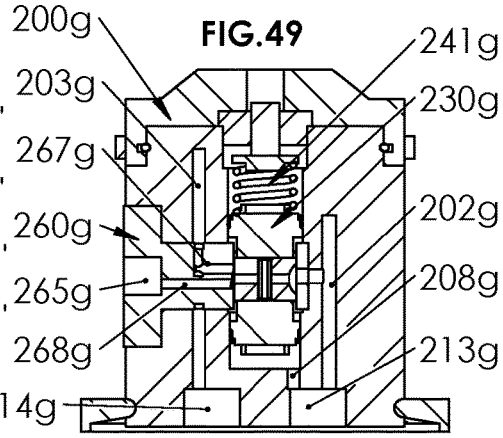


FIG. 50

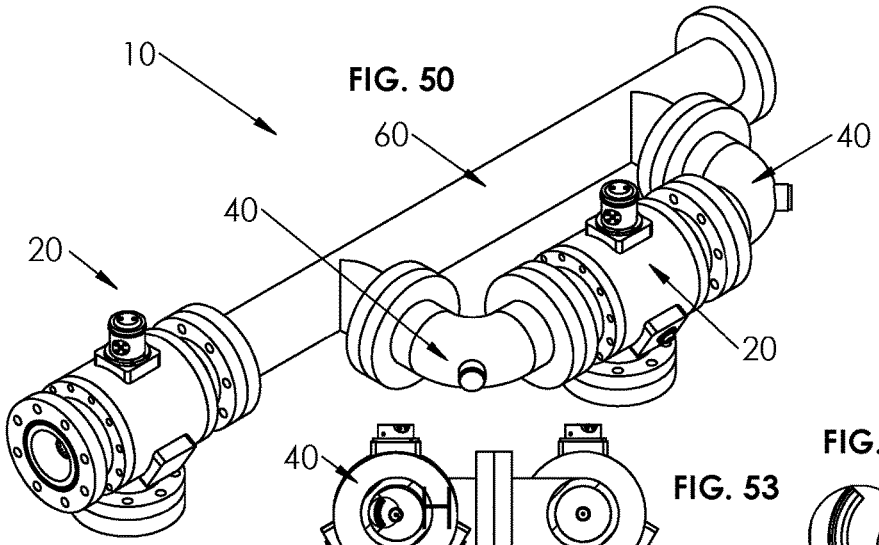


FIG. 52

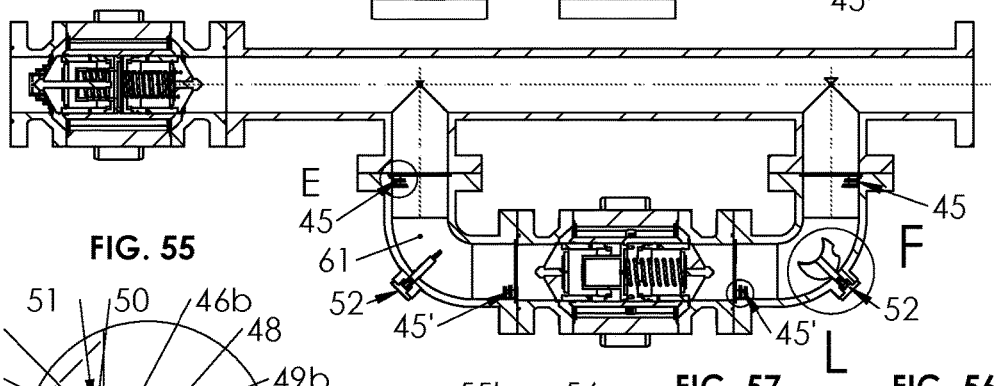
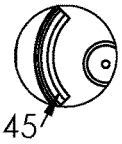


FIG. 53

FIG. 54



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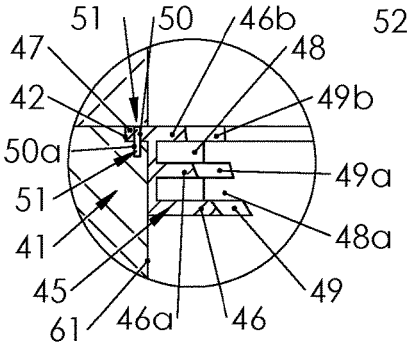


FIG. 57

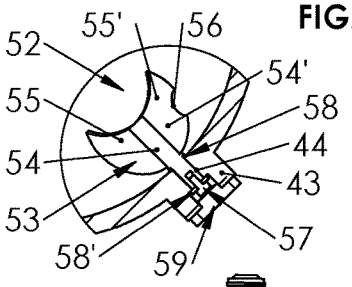


FIG. 56

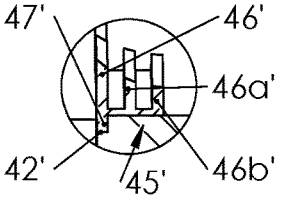
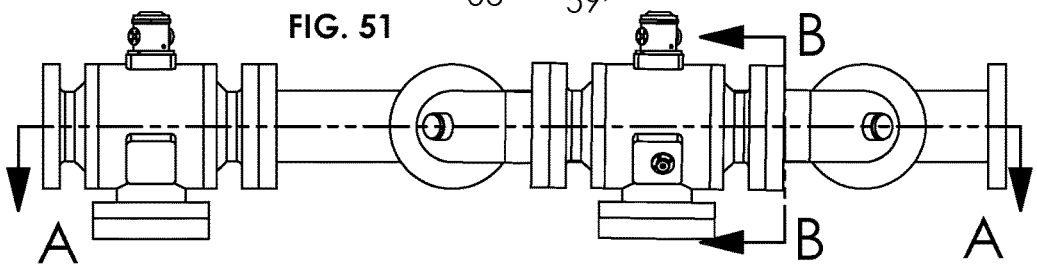


FIG. 51



HYBRID HIGH INTEGRITY PRESSURE PROTECTION SYSTEMS AND VALVES

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of provisional patent application Ser. No. 62/125,595 filed on Feb. 4, 2015 by the present inventor.

FEDERALLY SPONSORED RESEARCH

[0002] No

SEQUENCE LISTING OR PROGRAM

[0003] No

BACKGROUND

[0004] This invention relates to a Hybrid High Integrity Pressure Protection System (H-HIPPS) for severo services, the hybrid system includes a quick isolation subsystem between an overpressure zone and a normal pressure zone and a quick releasing subsystem between the overpressure zone and a lower pressure zone with quadruple redundancies for 30 year service without repair, more particularly, the hybrid system has a novel valve and a novel pilot, each with two independent plugs with metal to metal seal (buckling seal) B ring assemblies and a novel (attachable) A seal ring assembly to block or release over pressurize fluids without actuators for protecting the pipelines or the pressures vessels from surge pressure at the highest level of a system reliability, the quick releasing subsystem has novel hybrid and redundant pressure relief mechanisms, redundant pressure sensing mechanisms and secondary pressure surges depressor, cavitations and erosion suppression and detect mechanisms, while quick isolation subsystem has redundant closures members and cavitations reducer can be used for a control valve or pressure regulator with the best both static and dynamic performances, in most cases, two valves are used, one for isolating fluids, one for regulating the fluids.

[0005] When pipelines or pumping stations or piping terminals, pressurized fluids plants are in services, many times, the operations like open and closing, pumping and metering can cause water hammer and pressure surge, the pressure surge in pipelines or plant can cause many problems as following; (a) Axial temporal and permanent separation of flange joints (b) Pipe fatigue at weld joints (c) Longitudinal pipe splits (d) Severe damage to piping and piping supports (e) Severe damage to elbow (f) Pipe leak (g) High cost for constant repair (h) inaccurate metering due to leaks in supply stations (i) environmental pollution.

[0006] There are two solutions for the problem (1) to block the overpressure fluid zone into a normal pressure zone or (2) to release the overpressure fluid into a low pressure zone, the conventional quick blocking subsystems like HIPPS based on API **170** is equipped with two shut off valves, two actuators and pressure transmitters and a feedback control system, but this subsystem at this point is just a combination of conventional parts like valves, actuators and pressure sensors and controller at a lower system reliability and is constructed under overpressure class at least three time in overpressure fluid zone even for a short period time and waste lot of materials and capacity in normal pressure conditions, so far there is no single valve or actuator, which are developed for the high integrity system, while the conventional quick releasing subsystem is constructed as overpressure safety device under U.S. Department of Transportation, Pipeline Safety Regulations, Hazardous Liquids Part 195, paragraph 195.428, the subsystem includes the pressure surge relief valve s like plug axial pressure surge relief valves, those valves are widely used in the pipeline protection from pressure surge and constructed with main three functions sensing, tracking and releasing, the plug axial pressure surge relief valves have two types, a gas loaded and a pilot operated configurations, the gas loaded pressure surge relief system has a fast response time about 250 millisecond, but it is equipped with external energy resources like pressurized bottle nitrogen, pressure regulator, check valve, tubing, insolated plenum bottle and control boxes, the subsystem not only increase cost and reduce a system reliability and sensible to temperature swing, but also has high operation cost to remain the set pressure with high cavitation and erosion, while the pilot relief system is operated by internal fluid energy with a compact pilot, but the pilot has a remote pressure sensing function and slow response time about two second or more and is less tolerated with dirty fluid and unreliable, every pressure releasing causes 10 to 30% pressure or energy loss and with high cavitation and erosion, in short the both type subsystems have no redundant system and cannot provide a good seal at low temperature, or high temperature and have high blow down pressure up to 30% and waste significant fluid energy and need constant seal goods replacements.

[0007] So the flow control industry has long sought means of improving the performance of the pressure protection valve and systems valve, improving the seal, creating a robust hybrid, enabling the valve to handle various flows under multiple extreme conditions.

[0008] In conclusion, insofar as I am aware, no such a system is formerly developed with fully metal to metal seal, hybrid highly reliable pressure protection system, easy manufacturing at low cost, they can be used for blocking and releasing overpressure fluids in sever service.

SUMMARY

[0009] This invention provides a simple, robust, reliable and versatile hybrid pressure protection system for severe services or under extreme conditions. This hybrid pressure protection system not only release overpressure fluid into lower pressure zone but also block overpressure fluid into normal pressures zone, and greatly reduce total isolation time, increase reliability with four redundancies, the subsystem has a valve and a pilot, the valve has two pockets respectively to receive two plug assemblies, each plug assembly works as an independent valve, the pilot has two vertical bores respectively receive two pilot plug assemblies, each pilot plug assembly works as an independent pilot to control each closures assembly in the valve, each plug assembly has a metal B ring assembly for sustaining seals and Wiper slurry fluid or fluids with solid particles fast closing impact forces without damage, metal B ring assembly is based on buckling theory, the deformation of metal seal is away below yield strength of the material, the A ring with attachable function play a key role in the system for preventing pipe leak even under temporal separation of axial flange joint due to water hammer and keep the leakage between 0-50 ppm or under high thermal change and high pressure, the redundancy feature is applied for the valve and the pilot, those include two plug valves, two pressure

sensing devices, two pressure relief paths, two pressure protection methods, reach the highest level of system reliability over all prior arts or existing products the system comprises three type system with a normal open, normal closed and the combination.

[0010] This subsystem can be used for normal closed, normal open and between positions with small modifications, with a blind flange attached on the body, the subsystem has one inlet and one outlet for on-off or throttling applications, the pilot can be used for two pressure regulators with sensing port connected to outlet port.

[0011] The erosion/cavitation reducing assembly is other feature for the system to reduce cavitation and erosion level, it comprises a pair of trims and a rotor assembly, the trim assembly comprise a pair of fins each fin is defined by a front surface, area of fin and gaps between each fin, the trim has step bore with pin hole with one pin installed between the elbow and the flange, the rotor assembly has a rotor, the rotor has three blades, one of the blade with a slot, so the rotator will generate a unbalanced rotation as the fluid pass, in turn the unbalanced rotation will create a designed vibration, and the vibrations feature will change as the erosion process developed, the gaps between the elbow wall and the blades will increase, the erosion can be monitored, detected and predicted through the vibration data, while one of the blade with magnetic material, so the rotation can be monitored detected by a magnetic sensor or instrument, so those two data can be verified with high accuracy, those devices are very useful and critical for subsea and underground pipeline or remote area, where human accesses are impossible or difficult.

[0012] Finally the plug can be modified with a trim for handling cavitations and erosion application, the dynamic trim is installed in the outlet plug, the trim will not restrict the flow capacity as plug move between open and closed positions, in the most cases, the cavitation and erosion happen at small opening, as the plug has the conical front surface with multiple cylindrical rings to gradually restrict the open flow but with multiple holes to release the flow, such a arrange prevents the pressure drop below a fluid vapor pressure, so cavitations can be reduced or avoided, the front plate of the plug can be made with different materials from the base ring and be easily replaced.

[0013] Accordingly, besides objects and advantages of the present invention described in the above patent, several objects and advantages of the present invention are:

[0014] (a) To provide high redundant pressure protection system, such a system has the highest system reliability for serve services or extreme conditions.

[0015] (b) To provide a pressure sensing device with a fast response time and releasing time, so such a system can protect a pipeline or critical vessel for severe service and has long life and high reliability.

[0016] (c) To provide a metal to metal seal with ability to sustain high closing impact force for extreme conditions: fast closing, high pressure, cryogenic or high temperature or fire-safe applications. Such a seal ring can keep good static and dynamic seals with low leakage between 0-50 ppm.

[0017] (d) To provide a seal with an attachable feature under extreme conditions: high pressure, cryogenic or high temperature or fire-safe applications. Such a seal ring can keep good seals with low leakage between 0-50 ppm under axial temporal separation of flange joints.

[0018] (e) To provide a reliable pilot for controlling a valve in a pressure protection system, so the pilot can provide fast response time, reliable performance has and buildup-proof seal and mechanisms and long life for severe service.

[0019] (f) To provide a device with functions to reduce erosion and cavitation as well as to monitor, detect and predict the process of erosion and cavitation, so the system has an ability to prevent fluid leak and predict efficiently the repair damage or replacements at good timing before the accidents happen.

[0020] (g) To provide a highly efficient movable trim in a choked flow, so such a trim has a compact, simple structure to reduce the cavitations and erosions without high pressure drops.

[0021] (j) To provide a highly efficient trim to reduce the cavitations without reducing the flow capacity, so such a trim can handle slurry fluid or fluid with solid particles or dissipate fluid energy under high pressure like damping valve used in water dam.

[0022] (k) To provide a pressure protection system without external actuation, stem, so such a valve can avoid the actuation failure, a stem leak.

[0023] (l) To provide a pressure protection system with solid/liquid interaction mechanisms to reduce the blocking time and releasing time, so the system can reduce the damage of pressure surge to minimum and cost of the system.

[0024] (m) To provide fully metal to metal coal pressure protection system, so the system last 25 to 50 year service and fire safety service, the maintain period would increase at least five year period and reduce the operation cost and increase reliability.

[0025] (n) To provide heat reservoir mechanism, so the system can use less pressurized gas and reduce operation cost and increase reliability.

[0026] Still further objects and advantages will become apparent from study of the following description and the accompanying drawings.

DRAWINGS

Drawing Figures

[0027] FIG. **1** is an exploded, tripe cut view of a pressure protection subsystem constructed in accordance with this invention.

[0028] FIG. **2** is an exploded, quarter cut view of a pilot of FIG. **1**.

[0029] FIG. **3** is a front view of valve of FIG. **1**

[0030] FIG. **4** is a cross sectional view of valve of FIG. **2** along line A-A.

[0031] FIG. **5** is a cross sectional views of valve of FIG. **2** along line B-B.

[0032] FIG. **6** is a cross sectional view of valve of FIG. **4** along line C-C.

[0033] FIG. **7** is an "E" detail view of the valve of FIG. **5**.

[0034] FIG. **8** is a "D" detail view of in the valve of FIG. **5**.

[0035] FIG. **9** is a "F" detail view of in the valve of FIG. **5**.

[0036] FIG. **10** is a front view of pilot of FIG. **2**.

[0037] FIG. **11** is an ISO view of pilot of FIG. **10**
[0038] FIG. **12** is a cross sectional view of pilot of FIG. **10** along line A-A.
[0039] FIG. **13** is a cross sectional view of pilot of FIG. **10** along line B-B.
[0040] FIG. **14** is an "E" detail view of pilot of FIG. **12**
[0041] FIG. **15** is a "F" and "G" detail views of pilot of FIG. **13**
[0042] FIG. **16** is a front view of subsystem of FIG. **1**
[0043] FIG. **17** is a cross sectional view of pilot of FIG. **16** along line J-J.
[0044] FIG. **18** is a cross sectional view of pilot of FIG. **16** along line K-K.
[0045] FIG. **19** is a cross sectional view of valve of FIG. **16** along line G-G
[0046] FIG. **20** is a "T" detail view of valve of FIG. **19**
[0047] FIG. **21** is a "M" detail view of valve of FIG. **19**
[0048] FIG. **22** is a "P" detail view of valve of FIG. **19**
[0049] FIG. **23** is a "L" detail view of valve of FIG. **19**
[0050] FIG. **24** is a side view of an alternative subsystem of FIG. **1**
[0051] FIG. **25** is a cross sectional view of valve of FIG. **24** along line A-A.
[0052] FIG. **26** is a cross sectional view of pilot of FIG. **24** along line G-G.
[0053] FIG. **27** is a side view of an alternative subsystem of FIG. **1**
[0054] FIG. **28** is a cross sectional view of valve of FIG. **27** along line B-B.
[0055] FIG. **29** is a cross sectional view of valve of FIG. **27** along line F-F.
[0056] FIG. **30** is a "K" detail view of valve of FIG. **25**
[0057] FIG. **31** is a front view of an alternative subsystem of FIG. **1**
[0058] FIG. **32** is a cross sectional view of valve of FIG. **31** along line K-K.
[0059] FIG. **33** is a cross sectional view of valve of FIG. **32** along line L-L.
[0060] FIG. **34** is a cross sectional view of pilot of FIG. **31** along line R-R.
[0061] FIG. **35** is a cross sectional view of pilot of FIG. **31** along line P-P.
[0062] FIG. **36** is a front view of an alternative subsystem of FIG. **1**
[0063] FIG. **37** is a cross sectional view of valve of FIG. **36** along line A-A.
[0064] FIG. **38** is a cross sectional view of valve of FIG. **37** along line H-H.
[0065] FIG. **39** is a cross sectional view of valve of FIG. **36** along line C-C.
[0066] FIG. **40** is a "J" detail view of valve of FIG. **39**.
[0067] FIG. **41** is a cross sectional view of valve of FIG. **3**G along line D-D.
[0068] FIG. **42** is a front view of an alternative subsystem of FIG. **1**
[0069] FIG. **43** is a cross sectional view of valve of FIG. **42** along line B-B.
[0070] FIG. **44** is a cross sectional view of valve of FIG. **43** along line D-D.
[0071] FIG. **45** is a cross sectional view of pilot of FIG. **42** along line A-A.
[0072] FIG. **46** is a cross sectional view of pilot of FIG. **42** along line F-F.
[0073] FIG. **47** is a front view of an alternative pilot of FIG. **42**
[0074] FIG. **48** is a cross sectional view of valve of FIG. **47** along line G-G.
[0075] FIG. **49** is a cross sectional view of valve of FIG. **47** along line H-H.
[0076] FIG. **50** is a ISO view of a pressure protection system constructed in accordance with this invention.
[0077] FIG. **51** is a front view of the system of FIG. **50**
[0078] FIG. **52** is a cross sectional view of the system of FIG. **51** along line A-A.
[0079] FIG. **53** is a cross sectional view of the system of FIG. **51** along line B-B.
[0080] FIG. **54** is a "H" detail view of gate valve of FIG. **53**.
[0081] FIG. **55** is a "E" detail view of gate valve of FIG. **52**.
[0082] FIG. **56** is a "F" detail view of gate valve of FIG. **52**.
[0083] FIG. **57** is a "L" detail view of gate valve of FIG. **52**.

REFERENCE NUMBER IN DRAWING

[0084] **10** Pressure protection system
[0085] **20** Pressure relief valve
[0086] Normal Closed
[0087] **20***a* Gas/liquid Pilot
[0088] **20***b* Gas/Gas pilot
[0089] **20***c* Liquid/liquid Pilot
[0090] **40** elbow assembly
[0091] **41** elbow
[0092] **42** step bore
[0093] **43** boss
[0094] **44** rotor hole
[0095] **45** trim assembly
[0096] **46** fin
[0097] **47** step
[0098] **48** gap
[0099] **60** pipe line
[0100] **61** elbow bore
[0101] **100** Valve a, b, c, d, e, f,
[0102] **101** body
[0103] **102** Inlet a, b
[0104] **103** Outlet,c
[0105] **104** Internal housing
[0106] **105** housing bore
[0107] **106** ID
[0108] **107** rib
[0109] **108** front surface
[0110] **109** seat pocket shoulder
[0111] **110** seat pocket
[0112] **111** groove bore with W teeth
[0113] **112** groove
[0114] **113** pocket port
[0115] **114** release port
[0116] **115** pocket hole
[0117] **116** cavity
[0118] **117** pocket
[0119] **118** seal shoulder
[0120] **119** OD forming step bore
[0121] **120** OD lock bore
[0122] **121** Seat pocket
[0123] **122** position groove
[0124] **123** side flange

[0125] **124** seat groove
[0126] **125** ID forming step bore
[0127] **126** Boss with W teeth
[0128] **127** snap ring groove
[0129] **128** seat
[0130] **129** ID lock bore
[0131] **130** plug assembly
[0132] **131** conical front plate
[0133] **132** OD
[0134] **133** step OD
[0135] **134** nose hole
[0136] **135** seat
[0137] **136** groove
[0138] **137** step
[0139] **138** joint hole
[0140] **139** cage
[0141] **140** base ring
[0142] **141** Front ID
[0143] **142** groove
[0144] **143** Step OD
[0145] **144** OD surface
[0146] **145** OD shoulder
[0147] **146** seat lock Hole
[0148] **147** bearing hole
[0149] **148** holder
[0150] **149** bottom slots
[0151] **150** B-ring assembly a,b,c,d,e
[0152] **151** engaged ring
[0153] **152** Internal surface
[0154] **153** External surface
[0155] **154** C shape groove
[0156] **155** C shape bump
[0157] **156** Front end
[0158] **157** Back end
[0159] **158** multiple cylindrical rings
[0160] **159** holes
[0161] **161** Support ring
[0162] **162** Internal surface
[0163] **163** External surface
[0164] **164** C shape groove
[0165] **165** C shape bump
[0166] **166** Front end
[0167] **167** Back end
[0168] **168** trim assembly
[0169] **169** screw hole
[0170] **170** snap ring
[0171] fastener (setscrew or spring
[0172] **171** pin)
[0173] **172** seat
[0174] **173** needle
[0175] **174** gland
[0176] **175** needle valve
[0177] **176** rupture disc
[0178] **177** ball bearing assembly
[0179] **178** ball
[0180] **179** spring
[0181] **180** sensing valve
[0182] **181** groove
[0183] **182** middle wall
[0184] **183** volume substitute box
[0185] **184** solid head
[0186] **185** hollow head
[0187] **186** conical nose
[0188] **187** radial hole
[0189] **188** link hole
[0190] **189** screen
[0191] **190** unformed A ring
[0192] **273** hole
[0193] **274** top cover assembly
[0194] **280** clamp
[0195] **281** C shape lock ring
[0196] **282** position leg
[0197] **283** screw hole
[0198] **284** shear seal assembly
[0199] **191** OD
[0200] **192** ID
[0201] **193** Formed A ring
[0202] **194** W teeth groove
[0203] **194'** Mated W teeth groove
[0204] **195** adapter flange
[0205] **196** spring
[0206] **197** seal plug
[0207] **198** boss
[0208] **199** back plate
[0209] **20** Pressure block valve
[0210] Normal Open/between
[0211] **20***d* Gas/liquid Pilot
[0212] **20***e* Liquid/liquid Pilot
[0213] **20***f* Liquid/liquid Pilot
[0214] **49** front surface
[0215] **50** pin hole
[0216] **51** pin
[0217] **52** elbow rotor assembly
[0218] **53** rotor
[0219] **54** shaft
[0220] **55** blade
[0221] **56** slot
[0222] **57** screw
[0223] **58** washer
[0224] **59** cover
[0225] **200** Pilot a,b,c,d,e,f,g
[0226] **201** body
[0227] **202** main passageway
[0228] **203** link passageway
[0229] **204** plug bore
[0230] **205** plug step bore
[0231] **206** seat bore
[0232] **207** seat step bore
[0233] **208** sense port
[0234] **209** top groove
[0235] **210** top step
[0236] **211** bottom groove
[0237] **212** top surface
[0238] **213** pocket port
[0239] **214** release port
[0240] **215** bottom surface
[0241] **216** plug cover
[0242] **217** hole
[0243] **218** spring gland
[0244] **219** adjustable screw
[0245] **220** top cover
[0246] **221** top hole
[0247] **222** groove
[0248] **223** screw hole
[0249] **224** snap ring
[0250] **225** fixed ring
[0251] **226** screw hole
[0252] **227** setscrew

[0253] **228** OD surface
[0254] **229** hole
[0255] **230** plug assembly
[0256] **231** plug
[0257] **232** front side
[0258] **233** back side
[0259] **234** front side OD
[0260] **235** back side OD
[0261] **236** front side step
[0262] **237** front side shoulder
[0263] **238** back side step
[0264] **239** back side shoulder
[0265] **240** seal bore
[0266] **241** spring
[0267] **242** front seal
[0268] **243** hole
[0269] **244** seal surface
[0270] **245** corner seal surface
[0271] **246** back seal
[0272] **247** hole
[0273] **248** seal surface
[0274] **249** corner seal surface
[0275] **250** B-ring assembly,a,b,c,
[0276] **251** engaged ring
[0277] **252** Internal surface
[0278] **253** External surface
[0279] **254** C shape groove
[0280] **255** C shape bump
[0281] **256** Front end
[0282] **257** Back end
[0283] **258**
[0284] **259** notch
[0285] **260** seat cover
[0286] **261** front piston
[0287] **262** back plate
[0288] **263** front surface
[0289] **264** groove
[0290] **265** inlet port
[0291] **266** radial hole
[0292] **267** link hole
[0293] **268** main hole
[0294] **269** link slot
[0295] **270** base seal
[0296] **271** front surface
[0297] **272** back surface

DESCRIPTION

[0298] FIGS. **1-57** illustrate a pressure protection system **10** and subsystem **20** constructed in accordance with the present invention, the pressure protection subsystem **20** has six models **20***a*, **20***b*, **20***c*, **20***d*, **20***e*, **20***f* with six types of valves **100***a*, **100***b*, **100***c*, **100***d*, **100***e*, **100***f* and seven types of pilots **200***a*, **200***b*, **200***c*, **200***d*, **200***e*, **200***f*, **200***g*.

[0299] Referring FIGS. **1-23**,**50**, the subsystem **20***a* has a valve **100***a* and a pilot **200***a*, the valve **100***a* comprises a body **101***a* and two side flanges **123***a*, **123***a*' connected with the body **101***a* on the right and left sides with two inlets **102***a*, **102***a*', the body **101***a* has an internal housing **104***a* connected with the body **101***a* by three ribs **107***a*, **107***a*', and **107***a*", three ribs **107***a*, **107***a*', **107***a*" are respectively expended to three extrenal bosses **198***a*, **198***a*' and **198***a*", two plug assemblies **130***a*, **130** are respectively movably positioned in the internal housing **104***a* in an opposite direction between closed and open positions, the normal positions of the plug assemblies **130***a* and **130***a*' are in the closed position, the valve **100***a* has two pockets **117***a*, **117***a*', pocket **117***a* is defined by a middle wall **182***a* and the plug assemblies **130***a* and internal housing **104***a*, pocket **117***a*' is defined by the middle wall **182***a* and the plug assemblies **130***a* and internal housing **104***a*, the pocket **117***a*, **117***a*' are respectively connected to two pocket ports **113***a*, **113***a*' into pocket holes **115***a*, **115***a*' through the ribs **107***a*, **107***a*, **107***a*", the valve **100***a* has a cavity passageway **116***a* between the internal housing **104***a* and the body **101***a*, between the body **101***a* and side flange **123***a*, between the body **101***a* and side flange **123***a*', the cavity **116***a* is expended to an outlet **103***a*, an inlet **102***a* is sealed out from the cavity **116***a* by B ring assembly **150***d*, an inlet **102***a*' is sealed out from the cavity **116***a* by B ring assembly **150***c*, the cavity **116***a* is connected to release port **114***a*, a pressure sensing valve **180***a* is provided for sensing a pressure of pocket **117***a*, a rupture disc **176***a* with a needle valve **176***a* is provided for pressure safety protection in case of overpressure fluid not releasing at presetting max pressure limit and for sealing after rupture disc **176***a* is ruptured, the pilot **200***a* has two pocket ports **213***a*, **213***a*' and a release ports **214***a*, two pocket ports **213***a*, **213***a*', release ports **214***a* are respectively connected to the pocket ports **113***a*, **113***a*' and release port **114***a* on the valve body **101***a*, and for control movements of the plug assemblies **130***a*, **130***a*', the pilot **200***a* functions as two independent three-ways/two position valves and has two plug assemblies **230***a*, **230***a*' to move between the two positions.

[0300] Referring FIGS. **1-6**, Body **101** includes the outlet **103** connected to the cavity **116***a* and connected with an adapted flange **195***a* to a fluid tank (not shown), the internal housing **104***a* has two grooves **112***a*, **112***a*' in the right and left sides, the body **101***a* also the pocket hole **115***a* through the rib **107***a* to a boss **198***a*' and the pocket hole **115***a*' through the rib **107***a*' to the boss **198***a*', the pressure sensing valve **180***a* has a cylindrical seat ring **172***a* with an edge engaged with a conical needle **173***a* in a pocket hole **115***a* for open and closed operations, a holder **148***a* has four slots **149***a* at a bottom for supporting the seat **172***a* and releasing overpressure from the pocket **115***a* to cavity **116***a*, the needle **173***a* is biased by a gland **174***a* and spring **179***a* for sensing a fluid pressure in pocket **117***a*, the rupture disc **176***a* and a needle valve **175***a* are installed with the holder **148***a*' in pocket hole **115***a*', a holder **148***a*' has four slots **149***a*' at a bottom for supporting the rupture disc **176***a* and releasing overpressure from the pocket **115***a*' to cavity **116***a*, the needle valve **175***a* is used for sealing off the pocket **116***a*' after rapture disc **176***a* is raptured, the body **102***a* has a lock groove **181***a*.

[0301] Plug assembly **130***a*' is disposed in a left side of valve with functions of a gas pressure control, immediate sensing, tracking and has a solid head **184***a* and a front plate **131***a* and a base ring **140***a*, the sealed pocket **117***a*' is formed by the plug assembly **130***a*', the middle wall **182***a* and the internal housing **104***a*, the volume substitute box **183***a* constructed with the middle wall **182***a* is used for reducing the pocket **117***a*' volume and the temperature effect and as a heat reservoir filled with liquids for averaging today and night time temperatures and reducing gas consumption.

[0302] Referring FIGS. **6-7**, plug assembly **130***a* is disposed in a right side of valve with functions of a liquid pressure control and immediate sensing, tracking and has a hollow head **185***a* and a front plate **131***a* and a base ring **140***a*, the pocket **117***a* is formed by the plug assembly **130***a*,

the middle wall **182***a* and the internal housing **104***a*, the head **185***a* has a conical front **186***a* and three radial holes **187***a* extended to an axial hole **188***a* for communicating and creating a pressure difference between a fluid in the inlet **102** and a fluid in the pocket **117***a*, a screen **189***a* is placed outside head **185***a* for slurry fluid applications, the head **185***a* has two functions (1) when the pressure sensing valve **180***a* starts to open and release into pocket hole **115***a*, the pressure in the pocket **117***a* start to drop and through hole **188***a* as well, head **185** will increase the pressure drop even bigger (2) when the pressure difference between the pocket **117***a* and inlet **102** become so big, the pressurized fluids in inlet **102***a* is to push the plug assembly **130***a* inwardly with full piston effect and full front area of the front plate **131***a*, because of no front open holes in the head **185***a* and front plate **240***a*, the fluid in the pocket **117***a* would pour out through two ways (a) pocket hole **115***a* and (b) head radial holes **187***a*, the relief streams of fluid through the head **185***a* release radially and to help the main fluids in inlet **102***a* even faster to release into the cavity **116***a* as the plug assembly **130***a* moves away from the closed position, the full piston effect creates the faster pressure relief than any existing pressure relief mechanism in comparison with the conventional relief valve with reduced piston areas due to open axial holes, the front plate **131***a* has a conical surface and a step bore **133***a* and four radial fastener holes **138***a* on the back side, the base ring **140***a* has four bearing holes **147***a* equally spanned on an outside diameter surface **144***a* respectively to receive four ball bearing assemblies **177** for supporting and balancing the plug assembly **130***a* and reducing moving frictions of the plug assembly **130***a*, the ball bearing assembly **177** has a ball **178** biased by spring **179**, the ball bearing assembly **177** is positioned over the groove **112***a* for stabilizing the plug assembly **130***a* at full open position for normal open applications and reducing speed of the plug assembly **130***a* and preventing secondary pressure surge as the plug assembly **130***a* is too fast to be closed for normal closed applications.

[0303] Referring FIG. **6-8**, a B ring (after Bump and Buckling) assembly **150***a* for providing dynamic seals under buckling condition between the cavity **116***a* and base ring **140***a*' is positioned In the left side of the body **101***a*, the B ring assembly **150***a* is disposed in a seat pocket **110***a* of Internal housing **104***a* and has an engaged ring **151***a* and a support ring **161***a*, the engaged ring **151***a* has an inside diameter surface **152***a*, an outside diameter surface **153***a*, a conical front end **156***a* and a conical back end **157***a*, the support ring **161** has an inside diameter surface **162***a*, an outside diameter surface **163***a*, a conical front end **166***a* and a conical back end **167***a*, the engaged ring **151***a* inserted into ring **161***a* with a fit is rolled together for creating a C shape groove **154***a*, a C shape bump **155***a* on the engaged ring **151***a* and a C shape groove **164***a*, a C shape bump **165***a* on the support ring **161***a*, two sets of B ring assemblies **150***a* in series are disposed in seat pocket **110***a*, the C bump **155***a* is engaged with the surface **144***a*' for creating initial contact seal force at a presetting pressure on a surface **144***a*' of base ring **140***a*', the B ring **151***a* with front end **156***a* and **161***a* with front end **166***a* are engaged with a conical pocket shoulder **109***a* for providing supports and seals, the outside diameter surface **163***a* of support ring **161***a* is engaged with the seat pocket **110***a* for seals, the C groove **164***a* is engaged with a snap ring **170***a*, four fasteners **171***a* are respectively fastener holes in the holes **169***a* to push the snap ring **170***a* and B ring **150***a* for creating a buckling condition at the C shape bump **155***a* between front end **156***a* and the C shape groove **154***a* and a buckling condition at the C shape bump **165***a* between front end **166***a* and the C shape groove **164***a* for increasing further contact seal force, between the C shape bump **155***a* and the surface **144***a*' at a working seal pressure.

[0304] Referring FIGS. **6-9**, plug assembly **130***a* and a B ring assembly **150***b* are provided with dynamic seals between the cavity **116***a* and the base ring **140***a*, B ring assembly **150***b* has an engaged ring **151***b* and a support ring **161***b*, the engaged ring **151***b* has an inside diameter surface **152***b*, an outside diameter surface **153***b*, a conical front end **156***b* and a flat back end **157***b*, the support ring **161***b* has an inside diameter surface **162***b*, an outside diameter surface **163***b*, a conical front end **166***b* and a flat back end **167***b*, ring **161***b* inserted into ring **151***b* is rolled together for creating a C shape groove **154***b*, a C shape bump **155***b* on ring **151***b* and a C shape groove **164***b*, a C shape bump **165***b* on the ring **161***b*, the C shape bump **155***b* is engaged with the surface **105***a* for an initial seal contract force between the internal housing **104***a* and a base ring **140***a*, the engaged ring **151***b* with the front end **156***b* against a conical pocket shoulder **145***a* for supporting and creating an initial seal contact force between the C shape bump and the surface **105***a* at a presetting seal pressure, support ring **161***b* is engaged with the seat pocket **145***a* for seals, the inside diameter surface **162***b* of ring **161***b* is engaged with a conical surface of **143***a* for seals, fasteners **171***b* (setscrews or pins) are inserted in the hole **144***a* to push the ring **161***b* and create a buckling condition at the C shape bump **155***b* between front end **156***b* and the C shape bump **154***b* for increasing further contact seal force between the C shape bump **155***b* and the surface **105***a* at a working seal pressure.

[0305] Referring FIGS. **2**, **12**, **13**, the pilot **200***a* is a dual three-way/two position valve, pilot **200***a* has a cylindrical body **201***a*, a pair of plug assemblies **230***a*, **230***a*' and a pair of seat covers **260***a*, **260***a*' and a pair of base seals **270***a*, **270***a*', a pair of plug covers **216***a*, **216***a*' and a top cover assembly **274***a* and clamp **280***a*, the body **201***a* has two vertical plug bores **204***a*, **204***a*' from a top surface **212***a*, bores **204***a*, **204***a*' respectively have step bores **205***a*, **205***a*' and to receive plug assemblies **230***a*, **230***a*', the body **201***a* has two horizontal seat bores **206***a*, **206***a*', seat bores **206***a*, **206***a*' are respectively expended to the bores **207***a*, **207***a*) and respectively to receive seat covers **260***a*, **260***a*', the body **201***a* has two main passageways **202***a*, **202***a*' and two link passageways **203***a*, **203***a*' from a bottom surface **215***a*, two main passageways **202***a*, **202***a*' are respectively expended to pocket ports **213***a*, **213***a*' and seat bores **206***a*, **206***a*', seat covers **260***a*, **260***a*' respectively are positioned in seat bores **206***a*, **206***a*' and have front pistons **261***a*, **261***a*' and back plates **262***a*, **262***a*', front pistons **261***a*, **261***a*' respectively have inlet ports **265***a*, **265***a*' expended to main holes **268***a*, **268***a*', the pistons **261***a*, **261***a*' respectively have seal surfaces **263***a*, **263***a*' and link holes **267***a*, **267***a*' expended to radial hole **266***a*, **266***a*', front pistons **261***a*, **261***a*' respectively have grooves **264***a*, **264***a*' connected to the radial holes **266***a*, **266***a*', plug assemblies **230***a*, **230***a*' are respectively positioned in the plug bores **204***a*, **204***a*' and plug step bores **205***a*, **205***a*' and are biased by springs **241***a*, **241***a*' and spring glands **218***a*, **218***a*', the plug bores **204***a*, **204***a*' are respectively covered by plug covers **216***a*, **216***a*, plug covers **216***a*, **216***a*' respectively have holes **217***a*, **217***a'*, top cover assem-

bly **274***a* has a top cover **220***a*, fixed ring **225***a*, snap ring **224***a* and eight setscrew **227***a*, top cover **220***a* placed on plug covers **216***a*, **216***a*' has bores **221***a*, **221***a*' respectively to aligned with holes **217***a*, **217***a*' and a groove **222***a* and eight threaded holes **223***a* equally located on an outside diameter surface **228***a* of the top cover **220***a* and expended to the groove **222***a*, the body **201***a* has a step **210***a* with a cyclical groove **209***a*, the snap ring **224***a* is placed between the groove of **222***a* and groove **209***a*, each of four setscrew **227***a* is threaded in each of four holes **223***s* in the top cover **223***a* to press the snap ring **224***a* into the groove **209***a* of the body **201***a*, a fixed ring **225***a* is placed on the top cover **220***a* to prevent the setscrew **227***a* from falling out and has four holes **229***a* respectively aligned up with four holes **223***s* without the setscrew **223** to block the setscrew **227***a*, each of four setscrew **227***a* is respectively threaded through holes **229***a* into thread holes **223***a* for securing a joint between fixed ring **225***a* and the top cover **220***a*, each of base seals **270***a*, **270***a*' has one of holes **273***a*, **273***a*', one of front seal surfaces **271***a*, **271***a*', one of back seal surfaces **272***a*, **272***a*', the plug assemblies **230***a*, **230***a*' respectively have plugs **231***a*, **231***a*' and shear seal assemblies **284***a*, **284***a*', shear seal assemblies **284***a*, **284***a*' respectively have front seal plates **242***a*, **242***a*', B rings **250***a*, **250***a*' and back seal plates **246***a*, **246***a*', shear seal assemblies **284***a*, **284***a*' respectively are disposed in seal radial bores **240***a*, **240***a*' and are against surfaces **264***a*, **264***a*' and surfaces **248***a*, **248***a*' for seals, the clamp **280***a* has a lock ring **281***a* and leg **282***a* with two sections, the clamp **280***a* is placed between groove **211***a* on pilot **200***a* and a groove **181***a* on the valve **200***a* for securing a joint, leg **282***a* has a fit with groove **181***a*, if the joint is permanent, the inference fit will be used, if the joint is a semi-permanent joint or for high vibration applications, the transitional fit will be used, the joint method replaces the conventional long through screw joint with benefit of redundancy of joint, less machining and high structure integrity, because of the clamp structure, the clamp **280***a* still has flexibility like long screw, bolts (not shown) are used for securing the joint between valve **100***a* and pilot **200***a*.

[0306] Pilot **200***a* has the pocket port **213***a*, release port **214***a* respectively connected to the pocket port **113***a* and release port **114***a* on the valve **100***a* for the liquid pressure control pressure track and pressure sensing, a distance sensing fluid from the upstream overpressure zone about 10 to 20 times diameter pipe away is connected to port **208***a*, a pressure fluid from the upstream fluid zone is connected to the inlet port **265***a*, the inlet port **265***a* is connected to main passageway **202***a* through holes **268***a*, **243***a*, **247***a*, and B ring **250***a* of seat assembly **284***a*, plug assembly **230***a* disposed in the plug bore **202***a*, the plug assembly **230***a* is biased by spring **241***a* at a lower position as a pressure in the sensing port **208***a* is lower than a presetting pressure, a pocket port **213***a* is connected with main passageway **202***a*.

[0307] Pilot **200***a* has the blocked release port **214***a*, the pocket port **213***a*' is connected to port **114***a* on the valve **100***a* for the gas pressure control, pressure track and pressure sensing, a regulated gas is connected to hole **217***a*' for a presetting pressure against a pressure in the sensing port **208***a*', the regulated gas in hole **217***a*' is connected to main passageway **202***a*' through passageway **203***a*', groove **264***a*' and holes **266***a*', **267***a*', **247***a*' **243***a*', main passageway **202***a*' is connected to port **213***a*', the inlet port **265***a*' is as a release port, as the plug assembly **230***a* is biased by spring **241***a*' and the regulated gas is at a lower position, as a pressure in the sensing port **208***a* is lower than a presetting pressure due to force of spring **214***a* and a difference area between plug bore **204***a*' and plug step bore **205***a*', a pocket port **213***a* is connected with main passageway **202***a*.

[0308] Referring FIGS. **14** to **15**, Plug assembly **230***a* is assembled with shear seal assembly **284***a*, the shear seal assembly **284***a* has the front seat **242***a*, back seat **246***a* and B ring **250***a*, front seat **242***a* has a flat seal surface **244***a* and an edge seal fillet **245***a*, back seat **246***a* has an edge seal fillet **249***a* and a flat seal surface **248***a*, B ring **250***a* has an engaged ring **251***a*, the engaged ring **251***a* has an inside diameter surface **252***b*, an outside diameter surface **253***a*, a conical front end **256***a* and a conical back end **257***a* ring **251***a* is rolled for creating C shape groove **254***b*, a C shape bump **255***b*, the C shape bump **255***a* is engaged with the surface **240***a* with a non-inference fit, B ring **250***a* is placed between front seat **242***a* and back seat **246***a* for creating buckling condition at the C shape bump **255***a* under compression between front seat **242***a* and back seat **246***a*, the front end **256***a* is engaged with the corner **249***a* for seals between B ring **250***a* and back seat **246***a*, while the back end **257***a* is engaged with the corner **245***a* for seals between B ring **250***a* and front seat **242***a*. Plug assembly **230***a* has a plug **231***a*' and B ring **250***b*, the plug **231***a*' has a step bore **236***a*' expended to a shoulder **236***a*', B ring **250***b* has an engaged ring **251***b*, the engaged ring **251***b* has an inside diameter surface **252***b*, an outside diameter surface **253***b*, a conical front end **256***b* and a "L" back end **257***b*, ring **251***b* is rolled for creating a C shape groove **254***b*, a C shape bump **255***b*, the engaged ring **251***b* placed in step bore **236***a*' has the front end **256***b* against shoulder **236***a*' for supporting and creating an initial seal contact force between the C shape bump **255***b* and the surface **204***a*' at a presetting seal pressure, a lock ring **258***b* with a slot placed in step **236***a* with a press fit is forced to push ring **251***b* for creating a buckling condition at a C shape groove **254***b* and C shape bump **255***b* for increasing further contact seal force between the C shape bump **255***b* and the surface **204***a*' at a working seal pressure, the slot can be broken for replacement of new B ring **250***b*, an engaged ring **250**C is the same as **250***b*.

[0309] Referring FIGS. **16**,**17**,**18**,**19**, the plug assembly **230***a* in pilot **200***a* move up due to the increased pressure in sensing port **208***a*, the pocket port **213***a* is connected to release port **214***a* through main passageway **202***a*', shear seal assembly **284***a*, hole **267***a* and passageway **203***a*, the plug assembly **130***a* moves away from a closed position, the plug assembly **230***a*' in pilot **200***a* moves up due to the pressure in sensing port **208***a*' increase over a presetting pressure, the pocket port **213***a*' is connected to release port **265***a*' through main passageway **202***a*', shear seal assembly **284***a*', hole **268***a*', the gas pressure from pocket port **213***a*' is increased over the limit by at least 10% due to temperature change not working pressure change, especially in summer between the day and night time, this pressure release method only release the hottest portion of gas from the pocket **117***a*', while the conventional method is to release the gas outside the valve and between the valve and a gas storage so those gases which are not hot hut high pressure in the gas storage are released, the conventional method wastes 30% of regulated, pressurized gas in comparison with this method.

[0310] Referring FIGS. **20**, the plug assembly **130***a* has a front plate **131***a*, a base ring **140***a* and four fasteners **171***a*, the front plate **131***a* has a step bore **133***a* and four holes **138***a*, base ring **140***a* has a groove **142***a* and a conical bore

141*a* engaged with the mating step bore **133***a* of front plate **131***a*, four fastener **117***a* (setscrews or pins) are respectively inserted in the holes **138***a* into the groove **142***a* for securing a repairable joint between the front plate **131***a* and base ring **140***a*, four fastener **117***a* (spring pins) can be used for securing a permanent join between the front plate **131***a* and base ring **140***a*.

[0311] Referring FIG. **21**, plug assembly **130***a*' and B ring assembly **150***c* are provided with seals between the side flange **123***a*' and front plate **131***a*' in the left side of the body **101***a*, the side flange **123***a*' has a snap ring groove **127***a*' with four fastener **171***a*, the B ring assembly **150***c* is disposed in a seat pocket **121***a*' of side flange **123***a*' and has an engaged ring **151***c* and a support ring **161***c* the engaged ring **151***c* has an inside diameter surface **152***c*, an outside diameter surface **153***c*, a conical front end **156***c* and a "L" back end **157***c*, the support ring **161***c* has an inside diameter surface **162***c*, an outside diameter surface **163***c*, a conical front end **166***c* and a flat back end **167***c*, ring **151***c* inserted into ring **161***c* with a fit is rolled together for creating a C shape groove **154***c*, a C shape Bump **155***c* on engaged ring **151***c* and a C shape groove **164***c*, a C shape bump **165***c* on the support ring **161***c* the C shape bump **155***c* has a clearance fit with seat **135***a*', when the plug assembly **130***a*' is approached to the seat **135***a*', support ring **161***c* with a longer front end **166***c* first is engaged with a conical pocket shoulder **137***a*' for absorbing closing impact forces and creating a buckling condition to force C shape bump **155***c* to move outward for providing seals between front end **166***c* and shoulder **137***a*', then the engaged ring **151***c* with front end **156***c* is engaged with conical pocket shoulder **137***a*' for absorbing closing impact forces and creating a buckling condition to force C shape bump **155** to engaged with seat **135***a*' at a presetting working pressure, the outside diameter surface **163***c* of support ring **161***a* is engaged with the seat pocket **110***a* for seals, a snap ring **170***a* is placed in the groove **127***a*', four fasteners **171***a* are to push the snap ring **170***a* to engaged with the C shape groove **164***c* of ring **161***c* for securing a joint between the B ring **150***c* and seat pocket **121***a'*.

[0312] Referring FIG. **22**, plug assembly **130***a* and a B ring assembly **150***d* are provided with seals between the side flange **123***a* and the front plate **131***a*, B ring assembly **150***d* has an engaged ring **151***d* and a support ring **161***d*, the engaged ring **151***d* has an inside diameter surface **152***d*, an outside diameter surface **153***d*, a conical front end **156***d* and a "L" back end **157***d*, the support ring **161***d* has an inside diameter surface **162***d*, an outside diameter surface **163***d*, a conical front end **166***d* and a flat back end **167***d*, support ring **161***d* inserted into engaged ring **151***d* is rolled together for creating a C shape groove **154***c*, a C shape bump **155***d* on engaged ring **151***d* and a C shape groove **164***d*, a C shape bump **165***d* on the support ring **161***d*, the C shape bump **155***d* has a clearance fit with seat **118***a*, when the plug assembly **130***a* is approached to the seat **118***a*, support ring **161***d* with a longer front end **166***d* is engaged first with a conical pocket shoulder **128***a* for absorbing closing impact forces and creating a buckling condition to force C shape bump **155***d* to move outward for providing seal between front end **166***d* and shoulder **128***a*, then the engaged ring **151***d* with front end **156***d* is engaged with conical pocket shoulder **128***a* for absorbing closing impact forces and creating a bucking condition to force C shape bump **155***d* to engaged with seat **118***a* at a presetting working pressure, the outside diameter surface **153***d* of ring **151***d* is engaged with a step of front plate **131***a*, the "L" back end **157***d* is locked in step **137***a* for securing a joint between the ring **150***c* and plug assembly **130***a*.

[0313] Referring to FIG. **23**, a formed A ring **193***a* is placed between body **101***a* and side flange **123***a*. the body **101***a* has W shape teeth **111***a* with an angle between 75 to 105 degree in a lock conical bore **120***a* and an outside diameter forming step bore **119***a*, the side flange **123***a* has a mating boss **126***a* with mated W teeth and a conical lock bore **129** a and inside diameter forming step bore **125***a*, a unformed **190***a* has an outside diameter **192***a* placed in the forming step bore **119***a* and an inside diameter surface **192***a* placed in the inside diameter forming step bore **125***a*, after body **101** and said flange **123***a* are compressed, the unformed **190***a* becomes A formed ring **193***a* with W shape, the inside diameter surface **192***a* is attached to lock bore **129***a* and the outside diameter **191***a* is attached to lock bore **120***a*, there are other two unformed A rings **190***a*' and **190***a*', A ring **190***a*' has only inside diameter **192***a*' attached to lock bore **129***a*, A ring **190***a*" has only outside diameter **191***a*" attached to lock bore **120***a*, the attached A ring **190***a* is provided with robust seal solution even when the subsystem under water hammer and temporal axial flange separation, so far there is no attachable seal ring in use to solve the operation problem.

[0314] Referring to FIGS. **24-30**, the subsystem **20***b* based on subsystem **20***a* comprises valve **100***b* and pilot **200***b*, the valve **100***b* has two plug assemblies **130***b*, **103***b* for two gas pressure controls, two pressure tracking and two pressure relief, the subsystem **20***c* based on subsystem **20***a* comprises valve **100***c* and pilot **200***c*, a valve **100***c* based on valve **100***a* comprises two plug assemblies **130***c*, **103***c* for two liquid pressure control, two pressure tracking and two pressure relief, B ring **150***e* is placed in grooves **194***b* and **194***b*', each groove **194***b*, **194***b* have respectively bottom fillets and corners chamber, B ring **150***e* has an engaged ring **151***e*, the engaged ring **151***e* has an inside diameter surface **152***e*, an outside diameter surface **153***e*, a conical front end **156***e* and a conical back end **157***e*, ring **151***e* is rolled for creating a C shape groove **154***e*, a C shape bump **155***e*, the C shape bump **155***e* is engaged with the chamfers both grooves **194***b*, **194***b*', the both ends **157***e*, **156***e* are respectively engaged with two chamfers of grooves **194***b*, **194***b*' under a buckling condition.

[0315] Referring to FIGS. **31** to **35**, the subsystem **20***d* based on subsystem **20***a* has a valve **100***d* and pilot **200***d*, the valve **200***d* comprises two plug assemblies **130***d*, **103***d*' for blocking off, the valve **100***d* has one inlet **102***d* and one outlet **103***d* and a blind flange **195***d*, two release ports **114***d*, **114***d*' are blocked, the pocket ports **113***d*, **113***d* are open and respectively connected to pocket ports **213***d* and **213***d*' on the pilot **200***d* for gas or liquid pressure controls, the plug assembly **130***d*' is located on a side of an inlet **102***d* and sealed off by a head **184***d*' and biased by a spring **196***d*' at a normal open position, the plug assembly **130***d* is located on a side of an outlet **102***d* and sealed off by a head **184***d* at a normal open position, the head **184***d* is connected with a back plate **199***d* in a spring cage **139***d*, the spring cage **139***d* holds spring **199***d* for pushing plug assemble **130***d* inwardly and is trend to open, the cage **139***d* is secured with the middle wall **182***d* with bolts (not shown), pilot **200***d* has pocket ports **213***d*, **213***d*' and release port **214***d*, release ports **114***d*, **114***d*' are blocked, the pocket ports **213***d*, **213***d*' are open and respectively connected to pocket ports **113***d*, **113***d*

on the valve **100***d,* the sensing fluid comes into ports **208***d*, **208***d*' and against the plug assembly **230***d* and **203***d*', the fluid in the pockets **117***d,* **117***d*' are respectively connected respectively to ports **202***d,* **202***d*' through ports **213***d*, **213***d*', when a fluid pressure rises in the ports of **208***d* or **208***d*', the plug assembly **230***d* will move up and connect port **268***d* to **202***d*, port **268***d* is connected actuation fluid (not shown), the plug assembly **230***d*' will move up and connect port **268***d*' to **202***d*', then the plug assembly **130***d* and **130***d*' in valve **100***d* will move to closed positions.

[0316] Referring to FIGS. **36-41**, a subsystem **20***e* based on subsystem **20***d* comprise a valve **100***e* and pilot **200***e*, valve **100***e* comprises two plug assemblies **130***e,* **103***e*' for pressure regulation applications, two release ports **114***e*, **114***e*' are open and respectively connected with release ports **214***e* and **214***e*' on pilot **200***e*, the pocket ports **113***e*, **113***e* are open and respectively connected with pocket ports **213***e* and **213***e*' on the pilot **200***e*, the plug assembly **130***e*' is located on a side of an inlet **102***e,* the plug assembly **130***e*' is located on a side of an outlet **102***e*, pilot **200***e* has pocket ports **213***e,* **213***e*' and release ports **214***e,* **214***e*', release ports **214***e*, **214***de*' are open and respectively connected to pocket ports **114***ed*, **114***e*' on the valve **100***e,* the pocket ports **213***e,* **213***e*' are open and respectively connected with pocket ports **113***e*, **113***e* on the valve **100***e,* sensing fluids come into ports **208***e*, **208***e*' and against the plug assemblies **230***e* and **230***e*', the pockets **117***e,* **117***e*' are respectively connected to ports **202***e,* **202***e*', the plug assembly **230***e*' is disposed in plug bore **204***e* with a spring **241***e*', a pressurized fluid is constantly connected to ports **267***e*' and **268***e* by a slot **269***e* for regulating the pressurized fluid at a smaller step but more frequency, seat cover **260***e*' has a slot **269***e*' for communication between hole **268***e*' and **267***e*', the slot **269***e*' is constructed by three profiles, flat, comical and spherical, while the plug assembly **230***e* without a slot is disposed in plug bore **204***e* with a spring **241***e*, a pressurized fluid is constantly connected to ports **268***e*, **268***e*', ports **267***e* is connected to passageway **203***e* to release, so plug assembly **230***e*' acts as a control valve but moves fast with small changes, while plug assembly **230***e* acts as an on-off valve and move slow with large changes such a combination create the best dynamic and static performances with fast response but stable output fluid, no single pressure regulator can have such performance, plug assembly **130***e*' has a conical front plate **131***e*' on the outlet **103***e*, the conical front plate **131***e*' has a dynamic trim **168***e* the trim **168***e* has multiple coaxial cylindrical rings **158***e*' with multiple horizontal holes **159***e*' for controlling a relief fluid pressure drop above a vapor pressure and preventing cavitation, such a dynamic trim **168***e* not only control cavitation very effectively at small opening where the most cavitations happen, but also open the fluid area when the plug assembly **130***e*' at an open position and does not reduce the flow capacity unlike conventional static trim, the trim can be constructed as welding part or as an integral part with the front plate **131***e*.

[0317] Referring to FIGS. **42-46**, a subsystem **20***f* based on subsystem **20***e* comprises a valve **100***f* and pilot **200***f*, the valve **100***f* comprises two plug assemblies **130***f,* **130***f*' for pressure regulation applications, the two release ports **114***f*, **114***f*' are blocked, the pocket ports **113***f*, **113***f* are open and respectively connected with pocket ports **213***f* and **213***f*' of pilot **200***f*, the pocket ports **213***d,* **213***d*' are open and respectively connected with pocket ports **113***f*, **113***f*' on the main valve **100***f,* fluids in sensing ports **208***f*, **208***f*' are respectively connected to ports **213***g*, **213***g*' and are against the plug assembly **230***f* and **230***f*', the pockets **117***f,* **117***f* are respectively connected respectively with ports **202***f,* **202***f*' through the pocket ports **113***f*, **113***f*, the plug assembly **230***f* is disposed in plug bore **204***f* with a strong spring **241***f,* a pressurized fluid is constantly connected to port **268***f* by a slot **269***e* for regulating the pressurized fluid at a larger step but less frequency, the slot **269***e*' is constructed by three profiles, flat, comical and spherical, while the plug assembly **208***e* is disposed in plug bore **234***e*' with a weak spring **241***f* for regulating the pressurized fluid at a smaller step but high frequency, such a combination creates the best dynamic and static performances with fast response but stable output fluid, no single pressure regulator can have such performances.

[0318] Referring to FIGS. **47-49**, a pilot **200***g* based on **200***f* has two plug assemblies **230***g,* **230***g*', both pocket ports **213***dg*, **213***g*' and release ports **214***g*, **214***g*' are open and for receiving and releasing fluids as an independent pilot, both pocket ports **213***g*, **213***g*' are respectively connected to sensing ports **208***g*, **208***g*', the valve **200***g* acts as two pressure regulators, a pressurized fluid through **265***g* and **268***g* port is connected to port **243***g* at a low pressure, when a fluid pressure in port **213***g* increases, the plug assembly **230***g* will move up, the port **243***g* will connected to **267***g* to release the overpressure fluid, when a fluid pressure in port **213***g* decreases, the plug assembly **230***g* will move down, the port **243***g* will connected to **268***g* to receive the pressurized fluid and increases the fluid pressure In port **213***g*, because of the slots **269***e*, the pressure change is seamless and stable for precision control applications.

[0319] FIGS. **50-57** illustrate a hybrid pressure protection system **10** constructed in accordance with the present invention, the system **10** includes one of subsystems **20***e* for isolating over-pressurized fluid at a normal open position, one of subsystems **20***a,* **20***b,* **20***c* for releasing over-pressurized fluid at a normal closed position and subsystem **20***f*, **20***g* for both applications and a pipe **60** and two elbow assemblies **40** for connections from an over pressurized fluid to the pressure protection subsystems **20**, the elbow assembly **40** has elbow **41**, a rotor assembly **52** and a pair of trims **45**, **45**' and a pair of pins **51**, the elbow **41** has two step bores **42** on each of ends of elbow **41** and a boss **43** with rotor bore **44** on an outward side of a middle of the elbow **41** at 45 degree section, each step bore **42** has a pin hole **50**, trims **45** has three fins, **46**, **46***a,* **46***b* with two gaps **47**, **47***a* and three surfaces **46**, **46***a* and **46***b* defined by one of prolife a conical and spherical surface, the trim **45** has a step **47** with a hole **50***a* engaged with the bore **42** for reducing turbulent fluid and erosion in the outward wall of elbow **41** to average the fluid pressure gradient in the elbow **41** when the system **10** start to release an over-pressurized fluid, the pin **51** is inserted through hole **50** and hole **50***a* for securing the trim **45** with the elbow **41**. Trim **45**' has fins, **46**', **46***a*', **46***b*' and step **47**', the rotor assembly **52** is disposed in bore **61** for mixing a high speed fluid stream in the outward wall of the elbow **41** and a slow speed fluid stream in an inward wall of the elbow **41** and reducing the erosion on the outward wall of elbow **41**, The rotor assembly **52** has a rotor **53**, the rotor **54** has three blade **55**, **55**', **55**", blade **55** has a slot **56**, so when a fluid passes the elbow **41** and force the rotor **53** to rotate, the unbalanced rotor **53** will generate a unbalanced rotation and a designed vibration, as the erosions on the elbow **41** and rotor **54** progress, so does the vibration

features, so the level of erosion can be detected and monitored and predicted by a vibration sensor, one of blade **55**, **55'55'** are made out of a magnetic material, so an unbalanced rotation can be detected and monitored by a magnetic sensor, those two data will enhance the reliability of the data and accuracy of the predication of erosion and timing of replacement, they can be used undersea and underground pipelines.

CONCLUSIONS

[0320] The present invention provides a long sought solution—an inherent high integrity pressure protection system instead of a combination of conventional low integrity pressure protection devices, the solution is (1) actuator-less, without external actuators, the valve has no actuator joint failure, no additional pipe leak, piston leak and joint leak, no piston sticking, no unbalanced force, no force or energy loss on frication or motion conversion (2) stem-less, the valve has no stem leak issue, no joint broken and no installation issue, especially in subsea, the installation between the valve and actuator are very difficult (3) both blocking overpressure fluid into normal pressure zone and releasing overpressure fluid into low pressure zone, greatly reducing total shut off time or impact time, risk of water hamper damage or pressure surge in normal pressure zone, rather than the old response time, which is meaningless (4) by nature, the plug valve has the least volume replacement over all valves with a travel about ¼ of diameter, in blocking side, the back plug assembly is much faster to close than other conventional valves due to less fluid resistance with the same moving direction, secondly a combination of the immediate sensing and releasing and a distant sensing and releasing, for the first time, pilot load liquid pressure control with the pressure sensing valve, pocket pressure drop effect and full area piston effect can match with gas loaded pressure control in term of full relief time (4) redundancy, inherent redundancy include (a) the left and right plug assemblies in the valve (b) the left and right plug assemblies in the pilot (c) external and Internal actuation energies (d) gas and pilot loaded controls (e) immediate sensing and a distinct sensing (f) destructive and nondestructive pressure protection methods

[0321] The present invention discloses other breakthrough achievement—A Metal B ring, the metal B ring comprises the engaged ring and support ring for both static and dynamic seals applications, for the first time, metal seal for high speech impact seal because when the plug moves at speech of 00 ft./s to a closed position, most metal seal will deform and cause leaks, so no metal seal can survive at the speed 80 ft./s even with high flexible spring metal, the B ring is based on pipe buckling mechanism, which most engineers in the field would avoid, but here B ring can survive because of the buckling condition, the seal compression stress stays away below the yield strength of the materials, moreover B ring has the seals in both axial and radial seal areas and more support points to reduce stress value than any other seal rings, other is critical element for the invention is the rolling process, the rolling process not only creates the C shape groove and bump, but also strengthen material of the B ring by 30% due to the surface hardening, the joint between the engaged ring and the support ring under the buckling absorb the most of impact force without damage as a spring and heat dissipation through contact frictions, even the **316** stainless steel can be used for most applications, moreover the multiple B rings can be installed in a series, in short first B ring assembly also has capacities for axial and radial seals, no other all existing sealing device can provide, second it breaks the temperature limit from −250 to 1500 F, third it provides a dynamic seal under high temperature and high pressure, fourth it will last from 5 to 30 years without any replacement under high temperature, while non-metal seal material will deteriorate or age under sever service, so the applications with B ring will be quick pipe joint seals, subsea flow control systems for 25 years life time or, nuclear power plant for 60 years life time, or jet engines control valve or check valve with quick closed impact for millions cycles without replacement or failure.

[0322] The dual plugs in pilot is a heart of this invention if the two plugs in the valve act as the muscle, first the fully metal shear seal assembly is designed to shear off any buildup from dirty fluids between the seat cover and shear seal assembly during operation, second the B ring provides constant seals and spring force to push out the front and back seat against the seat cover and base seal for providing dynamic seals, instead of rubber O-rings and washer spring, second the novel porting structures with the axial port connected to release port through radial hole and a groove on one part of seat cover greatly reduce risk of leak and port block and part machining, third the slot between the through side port and axial port, greatly increase the function of the pilot for various applications, the slot includes multiple profiles, a flat, conical and spherical profiles, the most significant improvement is both plugs assembles not only work independently as two redundancies but act in a manner of synergy as a pressure regulator to produce both high dynamic performance—a fast response as pressure changes and static performances, stable pressure holding as pressure has no change with combinations of various springs and various slots, which no single regulator in any prior art can produces.

[0323] The full piston effect is a novel solution to the pilot operated system major problems—a slow response and inability to handle dirt fluids, the full piston effect is based on an optimal sold/liquid interaction mechanism on the plug with the combination of the direct sensing and the remote sensing, and the combination of direct release and indirect release, the full piston effect not only greatly increases the release speed of overpressure fluid, but also enhances sensibility for overpressure, sensing reliability and dirty fluid handling abilities with the shear seal assembly and the plug head screen.

[0324] The anti-cavitation plug trim in this invention provides a simple and effective way to reduce the cavitation without reducing the fluid capacity, the plug is constructed with multiple cylindrical rings on a conical front surface, each hole pass two layers of ring, so the fluid will pass the holes and change angle and move out along with the cylindrical ring, since the plug is movable, the flow condition can change any time unlike most fixed trim, it also can be used for water damping on dams or river or energy dissipating cone valve and terminal fluid control.

[0325] The elbow erosion control assembly is another innovation here, it provides a system solution not in in the prior arts, first the assembly provide a pair of fixed trim with multiple fins in the inlet and outlet of the elbow, the fastest fluid steam than ⅓ cross sectional area along with the outward wall of the elbow will divert to a middle stream and the slowest flow stream about ⅔ cross sectional area along with the inward wall of the elbow, second it provides a rotor assembly as dynamic trim to protect the outward wall of the

elbow for dissipating some of energy of the faster fluid stream, and mix it with rest of streams, finally, the most important element is to monitor, detect and predict the erosion process, the rotor will create a designed, signature vibration profiles with an unbalanced blade as well as has one blade with a magnetic material Instead of avoiding vibrations, the unbalanced rotor not only create unbalanced rotation and vibration, but also a magnetic rotation signal, so both data will create critical data in regarding of erosion of the elbow as well as fluid conditions and are verifiable for a point of analysis, this device is very critical and useful tool for the pipelines underground, subsea or remote areas, where human access are difficult or impossible.

[0326] The A ring as an attachable ring between a pair of mated W shape teeth is other feature in this invention, the feature of seal attachablility is so critical for most flange connection in pumping or compression station, the pipeline, nuclear power or chemical plants, any sudden closing of pipeline valve or pump shutoff, vibrations or earthquakes would create water hammer or cause axial temporal or permanent separations of flange joints, the sudden separations generate million volatile gas or poison fluid leak every year around the world, so far there is no solution for axial temporal separation of flange joints, A ring is a simple but effective solution, it either can be attached to the outside diameter of A ring or the inside diameter of A ring, or both the inside diameter and outside diameter of A ring, the materials can be soft metal or polymer materials or composite materials or metal with polymer coating.

[0327] The volume substitute box is a great improvement in this gas loaded application, this not only reduces portion of pressurized fluid sensible to temperature swing effect, greatly improved the pressure sensing reliability due to gas temperature change reduction and gas consumptions, but also works as a heat reservoir filled with liquids or heat storable materials or fluids in the pipelines for averaging daytime and night time temperatures differences.

[0328] Although the description above contains many specifications, these should not be construed as limiting the scope of the invention but as merely providing illustration of some of the presently preferred embodiments of this invention.

[0329] Thus, the scope of the invention should be determined by the appended claims and their legal equivalents, rather than by the examples given.

I claim:

1. A fluid control system comprising:

(a) a piping assembly having an inlet section and an outlet section ;

(b) a pressure control assembly having one of plurality of types including:

(b1) a pressure -release control assembly having two inlet ports connected respectively to said inlet section and one release port for releasing overpressure fluids, said pressure release control assembly having a body assembly, a pair of closure member assemblies movable positioned respectively in said body assembly and at least one B ring assembly placed between said body assembly and one of said closures member assemblies, at least one A ring assembly, a pilot assembly connected to a top of said body assembly by a lock clamp assembly, said body assembly has a body and an internal housing having at least three ribs respectively connected to said body, said Internal housing has a left cylindrical bore and a right cylindrical bore and a wall between said bores, said wall has one of plurality of types including a plate and a plate having at least one volume substitute box, the at least one volume substitute box has one of plurality of contents including gas and liquid and heat storable materials, said left cylindrical bore to receive one of said closure member assemblies for forming a left pocket, and said right cylindrical bore receive one of said closure member assemblies for forming a right pocket, said left bore having at least one left groove and said right bore having at least one right groove, said groove has a cross section defined by one of plurality of curves including a C curve and a V curve, said body connecting respectively two sides flanges for forming a cavity with said internal housing and said release port, said body having ports A, B, respectively connected to said right bore and said right pocket, and said left bore and said left pocket through one of the at least three ribs, ports C, D respectively connected to said cavity said pilot assembly having a pair of plug assemblies and main ports 1, 2 respectively connecting to said ports A,B of said body, release ports 3, 4 respectively connecting to said ports C, D of said body, said body assembly has at least one spring pressure sensing valve installed in a through bore of one of the at least three ribs with passages to said cavity, and a rupture disc and a needle valve installed in a through bore of one of the at least three ribs with passages to said cavity;

(b2) a pressure-shutoff control assembly having an outlet port and an inlet port connected said outlet section for shutting off overpressure fluid, said pressure-shutoff control having a body assembly, a pair of closure member assemblies movable positioned respectively in said body assembly and at least one B ring assembly placed between said body assembly and one of said closure member assemblies, at least one A ring assembly, a pilot assembly connected to a top of said body assembly by a lock clamp assembly, said body assembly has a body and an internal housing having at least three ribs respectively connected to said body, said internal housing has a left cylindrical bore and a right cylindrical bore and a wall between said bores, said wall has one of plurality of types including a plate and a plate having at least one volume substitute box, the at least volume substitute box has one of plurality of contents Including gas and liquid and heat storable materials, said left cylindrical bore to receive one of said closure member assemblies for forming a left pocket, and said right cylindrical bore receive one of said closure member assemblies for forming a right pocket, said left bore having at least one left groove and said right bore having at least one right groove, said groove has a cross section defined by one of plurality of curves including a C curve and a V curve, said body connecting respectively two sides flanges for forming a cavity with said internal housing and said release port, said body having ports A, B, respectively connected to said right bore and said right pocket, and said left bore and said left pocket

through one of the least three ribs, ports C, D respectively connected to said cavity, said pilot assembly having a pair of plug assemblies and main ports 1, 2 respectively connecting to said ports A, B of said body, release ports 3, 4 respectively connecting to said ports C, D of said body;

(b3) a hybrid pressure control assembly having:

(b3.1) at least one pressure-release control assembly having two inlet ports connected respectively to said inlet section and one release port for releasing overpressure fluids, said pressure release control assembly having a body assembly, a pair of closure member assemblies movable positioned respectively in said body assembly and at least one B ring assembly placed between said body assembly and one of said closure member assemblies, at least one A ring assembly, a pilot assembly connected to a top of said body assembly by a lock clamp assembly, said body assembly has a body and an internal housing having at least three ribs respectively connected to said body, said internal housing has a left cylindrical bore and a right cylindrical bore and a wall between said bores, said wall has one of plurality of types including a plate and a plate having at least one volume substitute box, the at least one volume substitute box has one of plurality of contents including gas and liquid and heat storable materials, said left cylindrical bore to receive one of said closures member assemblies for forming a left pocket, and said right cylindrical bore receive one of said closure member assemblies for forming a right pocket, said left bore having at least one left groove and said right bore having at least one right groove, said groove has a cross section defined by one of plurality of curves including a C curve and a V curve, said body connecting respectively two sides flanges for forming a cavity with said internal housing and said release port said body having ports A, B, respectively connected to said right bore and said right pocket, and said left bore and said left pocket through one of the at least three ribs, ports C, D respectively connected to said cavity, said pilot assembly having two plug assemblies and main ports 1, 2 respectively connecting to said ports A, B of said body, release ports 3, 4 respectively connecting to said ports C, D of said body, said body assembly has at least one spring pressure sensing valve installed in a through bore of one of the at least three ribs with passages to said cavity, and a rupture disc and a needle valve installed in a through bore of one of the at least three ribs with passages to said cavity; and

(b3.2) at least one pressure-shutoff control assembly having an outlet port and an inlet port connected said outlet section for shutting off overpressure fluid, said pressure-shutoff control having a body assembly, a pair of said closure member assemblies movable positioned respectively in said body assembly and at least one B ring assembly placed between said body assembly and one of said closure member assemblies, at least one A ring assembly, a pilot assembly connected to a top of said body assembly by a lock clamp assembly, said body assembly has a body and an internal housing having at least three ribs respectively connected to said body, said internal housing has a left cylindrical bore and a right cylindrical bore and a wall between said bores, said wall has one of plurality of types including a plate and a plate having at least one volume substitute box, the at least volume substitute box has one of plurality of contents including gas and liquid and heat storable materials, said left cylindrical bore to receive one of said closures member assemblies for forming a left pocket, and said right cylindrical bore receive one of said closure member assemblies for forming a right pocket, said left bore having at least one left groove and said right bore having at least one right groove, said groove has a cross section .defined by one of plurality of curves including a C curve and a V curve, said body connecting respectively two sides flanges for forming a cavity with said internal housing and said release port, said body having ports A, B, respectively connected to said right bore and said right pocket, and said left bore and said left pocket through one of the least three ribs, ports C, D respectively connected to said cavity, said pilot assembly having two plug assemblies and main ports 1, 2 respectively connecting to said ports A,B of said body, release ports 3, 4 respectively connecting to said ports C, D of said body.

2. The fluid control system of claim **1**, wherein the one of said closure member assemblies having a front plate and a base ring having a lock groove and at least two radial ball bearing holes, and a head, said front plate has a center through hole to receive said head, a back step bore to receive said base ring and a back counter bore having multiple radial fastener holes, said front plate having radial and axial seal surfaces and a front surface defined by one of a plurality profiles including a conical profile, a spherical profile and a conical profile having multiple concentric pipes, each of said pipes having multiple radial holes, the one of said closure member assemblies having multiple fasteners inserted respectively into said lock groove through said multiple radial fastener holes, said head has one of plurality of types including a solid head, a solid head having a spring holder, a head having a conical head having multiple radial holes extending to at least one axial hole and a step bore to receive a filter screen and a hollow body connected to the at least one axial hole, said closure member assembly having at least two ball/spring bearings placed respectively in the at least two radial ball bearing holes for controlling movements of said closure assembly, the one of said closure member assemblies having one of plurality of configurations including:

(2.1) a gas loaded closure member assembly having said volume substitute box and said solid head for releasing pressure;

(2.2) an internal liquid loaded closure member assembly having said hollow head and a spring for releasing pressure;

(2.3) an internal liquid loaded front closure member assembly having said solid heard and a spring for blocking pressure;

(2.4) an internal liquid load back closure member assembly having said solid head having said spring holder and a caged spring for blocking pressure;

(2.5) an internal liquid loaded back closure assembly having said solid head with said spring holder and a caged spring, and said front plate with said conical profile with said multiple concentric pipes for regulating pressure.

3. The fluid control system of claim **1**, wherein the at least one B ring assembly having an engaged ring and at least one support ring, said engaged ring has an internal surface defined by one of plurality of profiles including a conical profile and a cylindrical profile, an external surface defined by one of profiles including a conical profile and a cylindrical profile, a front end defined by one of plurality of profiles including a conical profile and spherical profile, and flat profile, a back end defined by one of plurality of profiles including a conical profile and spherical profile, flat profile, L shape profile, the at least one support ring has an internal surface defined by one of profiles including a conical profile and a cylindrical profile, an external surface defined by one of plurality of profiles including a conical profile and a cylindrical profile, a front end defined by one of plurality of profiles including a conical profile and spherical profile, flat profile, a back end defined by one of plurality of profiles including a conical profile and spherical profile, flat profile, L shape profile, the at one least B ring assembly has one of plurality of configurations including:

(3.1) the at one least B ring assembly having the at least one support ring and said engaged ring, a snap ring, multiple fasteners having one of plurality of types including a setscrew and pin, the at least one support ring engaged with said engaged ring with a fit is rolled together to form at least one groove having a C curve cross section and at least one bump having a C curve cross section, said body assembly has a seat pocket having a lock groove to receive said snap ring and multiple axial fastener holes expending into said groove, the rolled engaged ring and said rolled support ring positioned into said seat pocket, multiple fasteners respectively inserted in said multiple axial fastener holes to push said snap ring into said C groove under buckling conditions for providing axial and radial seals between the one of said closure member assemblies and said body assembly;

(3.2) the at one least B ring assembly having the at least one support ring and said engaged ring, multiple fasteners having one of plurality of types including a setscrew and pin, the at least one support ring engaged with said engaged ring with a fit is rolled together to form at least one groove having a C curve cross section and at least one bump having a C curve cross section, the one of said closure member assemblies has a seat pocket having multiple radial fastener holes to receive said fasteners, the rolled engaged ring and said rolled support ring are positioned into said seat pocket, said multiple fasteners inserted respectively in said holes to push the at least one support ring under buckling conditions and said engaged ring for providing axial and radial seals between the one of said closure member assemblies and said body assembly

(3.3) one of said plug assemblies having a plug having a seat step bore, said B ring assemble having said engaged ring and a lock ring having a break slot, said engaged ring is rolled to form at least one groove having a C curve cross section and a bump having a C curve cross section, said engaged ring placed in said seat step bore is biased by lock ring in said seat step bore with a fit for securing said engaged ring under buckling conditions;

(3.4) said body assembly having a pocket between said flange and said body, said pocket is defined by an upper groove and a lower groove, one of said grooves is defined by an inward chamfer, an outward chamfer, an inward fillet, an outward fillet, said B ring assemble having at least one of said engaged ring, the at least one of said engaged ring is rolled to form a groove having a C curve cross section and a bump having a C curve cross section, the at least one of said engaged ring placed in said pocket under buckling conditions having said front end and said back end respectively engaged said fillets of said grooves for first seals and said C bump engaged with said chambers for second seals;

(3.5) the one of said plug assemblies has a plug including a radial bore and a shear seal assembly movably positioned in said radial bore, said B ring assemble has said engaged ring rolled to form a groove having a C curve cross section and a bump having a C curve cross section, said shear seal assembly having a front seat and a back seat and said engaged ring between said front seat and said back seat and a through hole between said front seat and said back seat, said front seat having an outward flat surface and an inward surface having an edge defined by one of features including a fillet and a chamfer, said back seat having an outward flat surface and an inward surface having an edge defined by one of features including a fillet and a chamfer, said engaged ring engaged with said edge of said back seat and said edge of said front seat for seals among said engaged ring, said front seat and said back seat, whereby said front seat, said engaged ring and said back seat having seal means for providing seals among said engaged ring, said front seat and said back seat and spring means for providing spring forces against said front seat and said back seat.

4. The fluid control system of claim **1**, wherein said pilot assembly comprising a cylindrical body, said two plug assemblies and a pair of seat covers, a pair of springs, said body having a left vertical plug bore and a right vertical plug bore, a left horizontal seat bore extending to said left plug bore, a right horizontal seat bore extending to said right plug bore, each of said plug assemblies biased by one of said springs respectively movably positioned in one of said plug bores forming a pressure pocket has a radial bore and a shear seal assembly movably positioned in said radial bore having a through hole, each of said seat covers positioned in one of said two horizontal seat bores has a back plate having a groove and a front piston having an axial hole extending to a radial hole connected to said groove linked to one of said release ports 3, 4 and a through side hole having one of plurality of profiles including said through side hole having a slot connected to said axial hole and said through side hole having no slot connected to said axial hole, said shear seal assembly having a back of said through port connected constantly to one of said main ports 1, 2 and a front of said through port against one of said two seat cover between said axial hole and said through side hole for controlling porting, said pressure pocket is connected by one of a plurality of pressure resources including an internal porting pressure and

an external porting pressure, said pressure control assembly having one of plurality of porting system configurations including:

(4.1) a gas/liquid loaded pressure releasing porting system including said pilot assembly and said body assembly;

(4.2) a gas/gas loaded pressure releasing porting system including said pilot assembly and said body assembly;

(4.3) a liquid/liquid loaded pressure releasing porting including said pilot assembly and said body assembly;

(4.4) a fluid/fluid loaded pressure blocking porting system including said pilot assembly and said body assembly;

(4.5) a liquid/liquid loaded pressure regulating porting system including said pilot assembly and said body assembly;

5. The fluid control system of claim **1**, wherein said piping assembly having at least one elbow and at least one elbow erosion control assembly having a rotor assembly and a pair of trim assemblies, the at least one elbow has a through bore and a front step bore having a position hole, a back step bore having a position hole, a rotor bore on a middle of said elbow, each of said trim assemblies having a mated segmented cylindrical ring, and a mated segmented cylindrical step inserted respectively into said front step bore and said back step bore, a mated pinhole and a mated pin inserted respectively in said pinhole and said position hole for securing the each of said trim assemblies, the each of said trim assemblies respectively having at least two fins, inward surfaces of the at least two fins are defined by one of plurality of profiles including a conical profile and a spherical profile, said rotor assembly disposed in said rotor bore having at least two unbalanced blades for mixing fluid streams in said elbow and for generating unbalanced rotations and designed vibrations under fluid streams, one of the at least two unbalanced blades is made out of a magnetic material for generating a detectable vibration signal of said rotor.

6. The fluid control system of claim **1**, wherein the at least one A-ring assembly having an inside diameter forming step bore, an outside diameter forming step bore and positioned between said body and said side flange for providing seals having one of plurality of configurations including:

(6.1) said A ring assembly having a unformed flexible ring including an inside diameter and an outside diameter, a cylindrical counter bore having W shape teeth and a mated cylindrical boss having a mated W shape teeth and a conical bore having a smaller inside diameter than said inside diameter of said unformed flexible ring between said body and said side flange, said unformed flexible ring placed at said inside diameter forming step bore between said flanges is compressed to form a W shape and to fill a gap between said W shape teeth and said mated W shape teeth and attached to said body for providing seals between said side body and said side flange;

(6.2) said A ring assembly having a unformed flexible ring including an inside diameter and an outside diameter, a conical counter bore having W shape teeth and a smaller outside diameter than said outside diameter of said unformed flexible ring, and a mated cylindrical boss having a mated W shape teeth, said unformed flexible ring placed at said outside diameter forming step bore between said flange and said body is compressed to form a W shape and fill in a gap between said W shape teeth and said mated W shape teeth and attached to said side flange for providing seals between said body and said side flange;

(6.3) said A ring assembly having a unformed flexible ring including an inside diameter and an outside diameter, a conical counter bore having W shape teeth, said conical counter bore having a smaller outside diameter than said outside diameter of said unformed flexible ring, a mated cylindrical boss having a mated W shape teeth and a conical bore having a lager inside diameter than said inside diameter of said unformed flexible ring, said unformed flexible ring placed at said outside diameter forming step bore, said inside side diameter forming step bore between said flange and said body is compressed and to form a W shape and to fill a gap between said W shape teeth and said mated W shape teeth and attached respectively to said body and said side flange for providing seals between said body and said side flange.

7. The fluid control system of claim **1**, wherein said body assembly has one of plurality of structures including a three-pieces body assembly and a two-pieces body assembly.

8. In a fluid control system comprising:

(a) a pilot assembly comprising a cylindrical body having main ports 1, 2, release ports 3, 4, a pair of plug assemblies, a pair of seat covers, a pair of springs, said body having a left vertical plug bore and a right vertical plug bore, a left horizontal seat bore extending to said left plug bore, a right horizontal seat bore extending to said right plug bore, each of said plug assemblies biased by one of said springs respectively movably positioned in one of said two plug bores for forming a pressure pocket has a radial bore and a shear seal assembly movably positioned in said radial bore, said shear seal assembly having a through hole and a front seat and a back seat and an engaged ring between said front seat and said back seat, said front seat having an outward flat surface and an inward surface having an edge defined by one of features including a fillet and a chamfer, said back seat having an outward flat surface and an inward surface having an edge defined by one of features including a fillet and a chamfer, said engaged ring having a front end defined by one of profiles including a conical profile and a spherical profile, and a back end defined by one of profiles including a conical profile and a spherical profile respectively engaged with said edge of said back seat and said edge of said front seat for seals among said engaged ring, said front seat and said back seat, said engaged ring is rolled to form a groove having a C curve cross section and a bump having a C curve cross section, each of said seat covers positioned in one of said horizontal seat bores has a back plate having a groove and a front piston having an axial hole extending to a radial hole connected said groove into one of said release ports 3, 4 and a through side hole having one of plurality of structures including said through side hole having a slot connected to said axial hole and said through hole having no slot connected to said axial hole, said shear seal assembly having a back of said through hole connected constantly to one of said main ports 1, 2 and a front of said through hole against one of said two seat covers between said axial hole and said through side hole for porting controls, said pressure pocket is con-

nected by one of a plurality of pressure porting systems including an internal porting system and an external porting system ;

(b) at one least B ring assembly having an engaged ring and at least one support ring, a pocket, said engaged ring has an internal surface defined by one of plurality of profiles including a conical profile and a cylindrical profile, an external surface defined by one of profiles including a conical profile and a cylindrical profile, a front end defined by one of plurality of profiles including a conical profile and spherical profile, and flat profile, a back end defined by one of plurality of profiles including a conical profile and spherical profile, flat profile, L shape profile, the at least one support ring has an internal surface defined by one of profiles including a conical profile and a cylindrical profile, an external surface defined by one of plurality of profiles including a conical profile and a cylindrical profile, a front end defined by one of plurality of profiles including a conical profile and spherical profile, flat profile, a back end defined by one of plurality of profiles including a conical profile and spherical profile, flat profile, L shape profile, the at one least B ring assembly has one of plurality of configurations including:

(b.1) the at one least B ring assembly positioned in said pocket having the at least one support ring and said engaged ring a snap ring and multiple fasteners, the at least one support ring receiving said engaged ring with a fit are rolled to form at least one groove having a C curve cross section and at least one bump having a C curve cross section, said pocket having a lock groove and multiple fasteners holes extending into said groove, said snap ring is placed in the said lock groove, said multiple fasteners inserted respectively into said multiple fasteners holes to push said snap ring into said groove having C curve cross section under buckling conditions for proving axial surface seals and radial surface seals;

(b.2) the at one least B ring assemble having said engaged ring and a lock ring having a break slot and a plug having a step bore, said engaged ring is rolled together to form a groove having a C curve cross section and a bump having a C curve cross section, said engaged ring installed on said step bore with a fit is biased by said lock ring for providing buckling conditions and locking said engaged ring;

(b.3) said pocket defined by an upper groove and a lower groove, said groove is defined by an inward chamfer, an outward chamfer, an inward fillet an outward fillet, said B ring assemble having at least one of said engaged ring, the at least one of said engaged ring is rolled to form a groove having a C curve cross section and a bump having a C curve cross section, the at least one of said engaged ring placed in said pocket under buckling conditions having said front end and said back end respectively engaged said fillets of said grooves for first seals and said C bump engaged with said chamfers for second seals.

9. In a fluid control system comprising:

(a) at least one A-ring assembly having an inside diameter forming step bore, an outside diameter forming step bore between flanges for providing seals, the at least one A ring assembly has one of plurality of configurations including:

(a.1) the at least one A ring assembly having a unformed flexible ring having an inside diameter and an outside diameter, a cylindrical counter bore having W shape teeth and a mated cylindrical boss having a mated W shape teeth and a conical bore having a smaller inside diameter than said inside diameter of said unformed flexible ring between said flanges, said unformed flexible ring placed at said inside diameter forming step bore between said flanges is compressed to form a W shape and to fill a gap between said W shape teeth and said mated W shape teeth and attached to one of said flanges for providing seals between said flanges;

(a.2) the at least one A ring assembly having a unformed flexible ring having an inside diameter and an outside diameter, a conical counter bore having W shape teeth and a smaller outside diameter than said outside diameter of said unformed flexible ring, and a mated cylindrical boss having a mated W shape teeth, said unformed flexible ring placed at said outside diameter forming step bore between said flanges is compressed to form a W shape and fill in a gap between said W shape teeth and said mated W shape teeth and attached to one of said flanges for providing seals between said flange;

(a.3) the at least one A ring assembly having a unformed flexible ring having an inside diameter and an outside diameter, a conical counter bore having W shape teeth, said conical counter bore having a smaller outside diameter than said outside diameter of said unformed flexible ring, a mated cylindrical boss having a mated W shape teeth and a conical bore having a lager inside diameter than said inside diameter of said unformed flexible ring, said unformed flexible ring placed at said Inside diameter forming step bore, said outside diameter forming step bore between said flanges is compressed and to form a W shape and to fill a gap between said W shape teeth and said mated W shape teeth and attached respectively to said flanges for providing seals between said flanges.

(b) at least one bending section and at least one erosion control assembly having a rotor assembly and a pair of trim assemblies, the at least one bending section has a through bore and a front step bore having a position hole, a back step bore having a position hole, a rotor bore on a middle of the at least one bending section, each of said trim assemblies having a mated segmented cylindrical ring having a mated segmented cylindrical step inserted respectively into said front step bore and said back step bore, a mated pinhole and a mated pin inserted respectively in said pinhole and said position hole for securing the each of said trim assemblies, the each of said trim assemblies respectively having at least two fins, inward surfaces of the at least two fins are defined by one of prolife a conical profile and spherical profile, said rotor assembly disposed in said rotor bore having at least two unbalanced blades for mixing fluid streams in said elbow and for generating unbalanced rotations and designed vibrations under fluid streams, at least one of the at least two unbalanced blades is made out of a magnetic material for generating a detectable vibration signal of said rotor.

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